INDEXED

Marine Engineering

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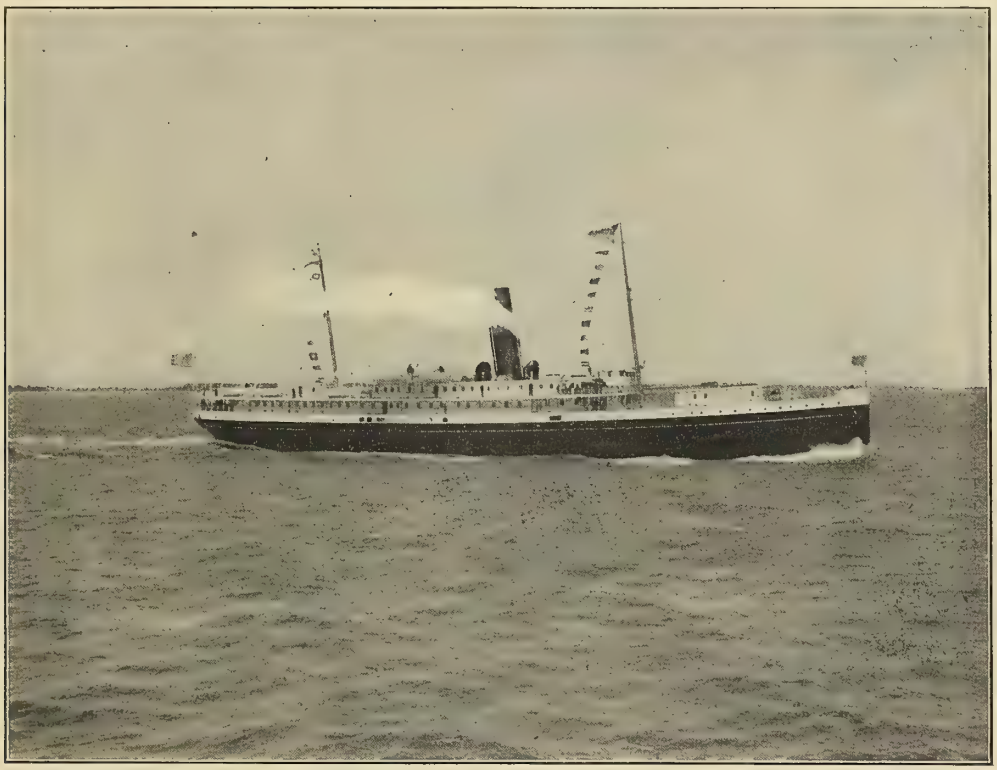
STEAMSHIP MONROE, OF THE OLD DOMINION LINE.

One of the finest steamers in any trade running out of New York harbor is the steamship *Monroe*, the latest addition to the fleet of the Old Dominion Steamship Company. This ship was recently completed by the Newport News Shipbuilding and Dry-Dock Company, and is for service on the main line of steamers plying between New York and Norfolk. The ships of this line have long been popular with passengers traveling along the coast, and the *Monroe* outranks the other vessels of the line in size and general features. She is a steel screw steamer of the hurricane-deck type, with complete hurricane deck, and partial shade deck extending from the foremast to the stern for the passenger accommodations. The hull is of steel to the hurricane deck, and all deck houses above are paneled joiner work. In general appearance she resembles the other ships of the Old Dominion fleet, but has more superstructure. Like them she is rigged as a two-masted schooner, with steel pole masts well raked. Her interior arrangement is, however, quite different, and in dimensions and power she exceeds them considerably. She was built to the rules of, and for the highest classification in, the American Bureau of Shipping for vessels in the coastwise trade, and was designed especially for the freight and passenger traffic, her accommodations for the latter being strictly first-class, while all necessary appliances for quick and easy handling of package freight have been provided.

Her principal dimensions will be found in the appended data card.



NEW COASTING STEAMER MONROE, OF THE OLD DOMINION LINE.

HULL CONSTRUCTION.

As indicated on the plans published herewith, she is a single-bottom ship with three complete decks, and orlop deck forward and aft of machinery space. She is built with continuous plate keel and keelson, the latter extending 16 1-2 inches above the floors with rider plate on top. The flat plate keel is 36 inches by 35 pounds reduced to 27 pounds forward, and is double for three-fifths length, the inner keel being 24 inches by 26 pounds for one-half length and 24 pounds for remainder. The center keelson is 22 pounds, connected to keel, floor stringers, and rider plate with double 6 by 4-inch by

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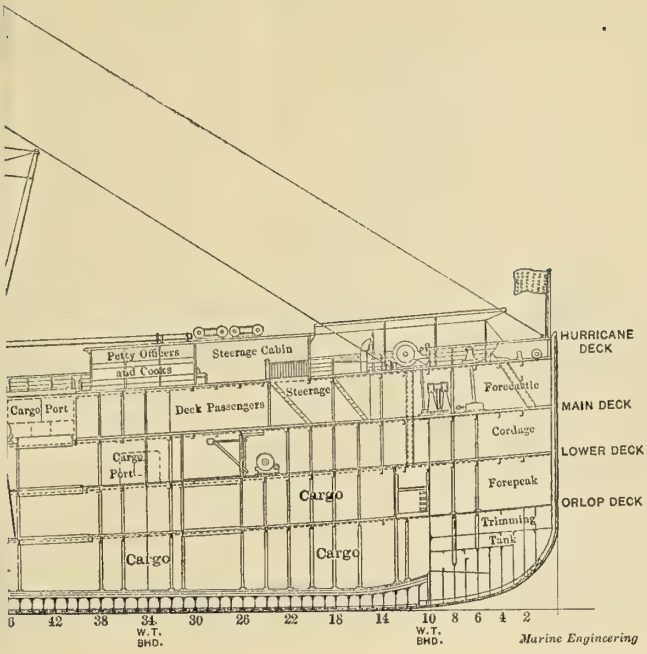
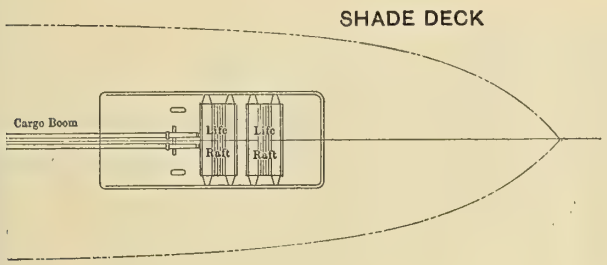
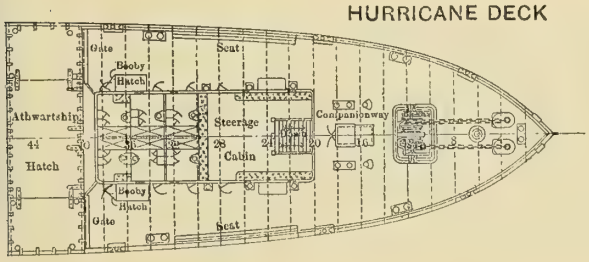
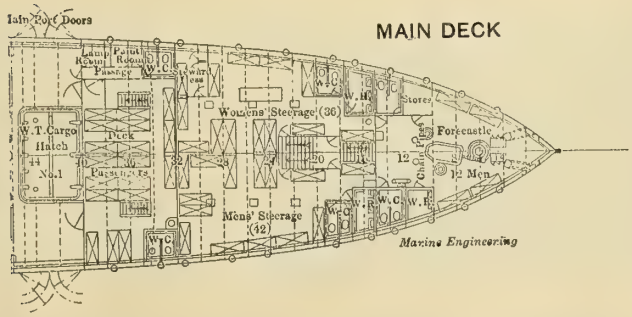
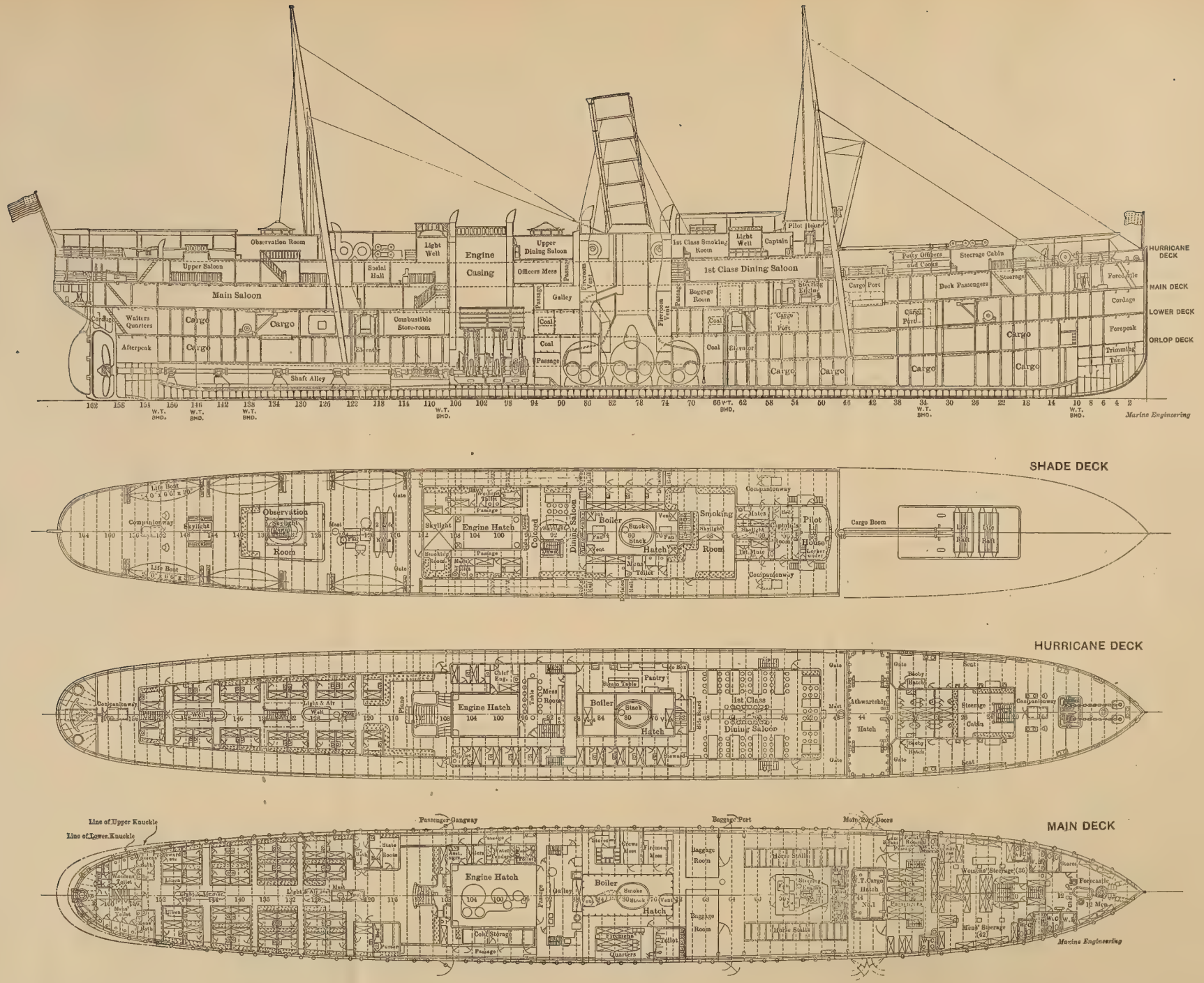






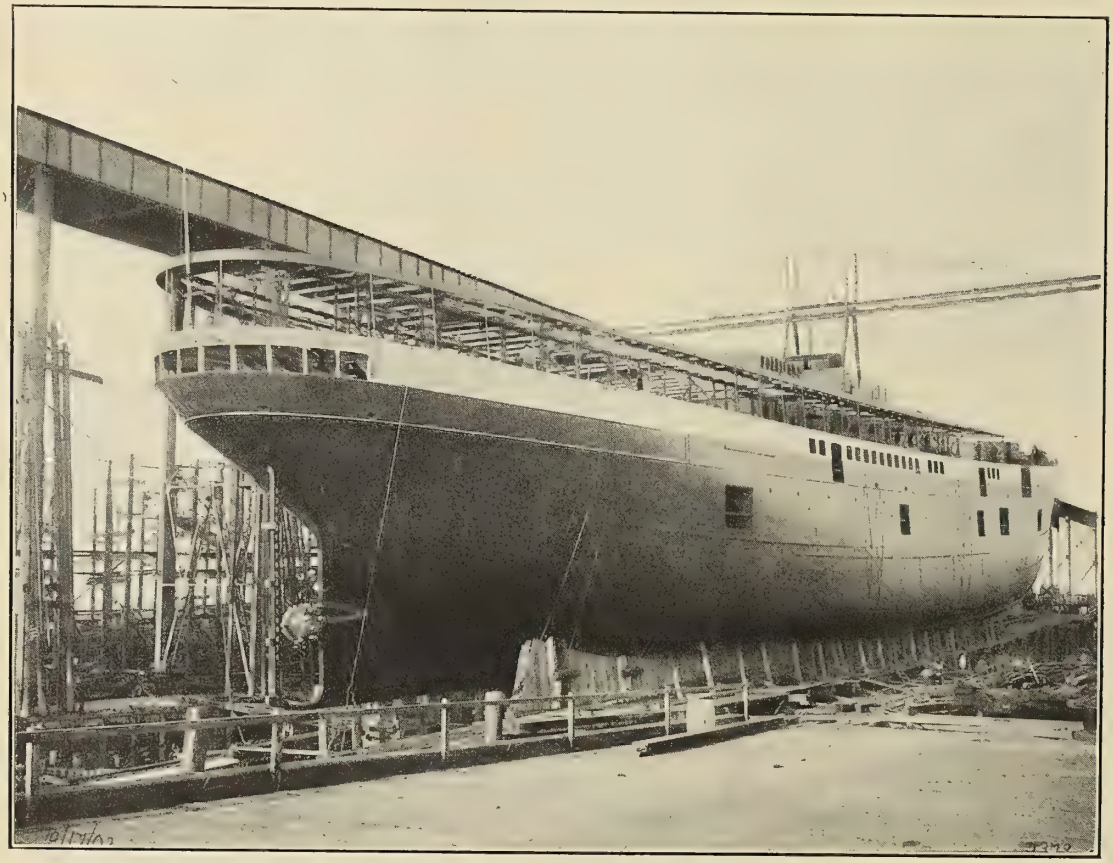


WS SHIPBUILDING AND DRY-DOCK COMPANY.



INBOARD PROFILE AND DECK PLANS OF THE OLD DOMINION STEAMER MONROE, BUILT BY THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

15-pound angles; the rider plate is 12 5-8 inches by 22 pounds for one-half length, reduced at ends; and the floor stringers on each side of center keelson are 21 3-4 inches by 22 pounds. The center line keelson is carried as far forward and aft as practicable and is rigidly connected to the stem and stern frame. The lower part of the stem is a steel casting shaped to suit the keel plate at its lower end and scarfed at its upper end to the wrought-iron stem proper, which is 10 1-2 by 2 3-4 inches. The stern frame is an iron forging 11 by 6 3-4 inches in the propeller post and 10 1-2 by 5 1-2 inches in the rudder frame, with all bosses for rudder pintles forged on. The rudder is of the double-plate type with forged frame and white pine filling. The frame is composed of a steel casting scarfed to a wrought-iron forging. There are four steel pintles, all fitted with brass sleeves and working in lignum-vitæ bushings. The rudder stock is a separate forging, bolted to the rudder through horizontal flanges. The weight of the rudder is taken by a flat deck plate with brass ring and a deep bearing lined with white metal.



STERN VIEW OF THE STEAMER MONROE BEFORE LAUNCHING.

The *Monroe* is framed with angle and reverse bars and fitted with solid floors on every frame, the latter being 29 inches by 21 pounds, with 24 pounds in machinery space and 16 pounds at ends. In the engine room deep floors are fitted to form the engine foundation. Frames are spaced 26 inches throughout the ship and are continuous from keel to hurricane deck from stem to the over-all hatch; for the remainder of length they extend to main and hurricane decks alternately. The main frames are 6 by 3 1-2 inches by 14 1-2 pounds to 13 pounds at ends, and reverse frames are 4 1-2 by 3 inches by 11 pounds throughout. The latter extend to main and hurricane decks alternately. Double frames are fitted at all water-tight bulkheads and in machinery space, and web frames 21 inches by 20 pounds are fitted to lower deck. Web frames are also fitted at each side of all cargo ports and in the cargo space between main and hurricane decks. There are three keelsons on each side in the lower hold. The upper and lower bilge keelsons have a 6 by 4-inch by 16 1-2 pound angle back to back, with a 10 by 3 1-2-inch by 26.5-pound bulb angle on inside of frames. The side keelsons are 15-pound plate fitted intercostally between floors and connected by single angle to shell and double angles on top of floors, all angles being 6 by 4 inches by 16 1-2 pounds. All keelsons run the entire length of the ship and form breast hooks at ends. Where they pass through the boiler space, the side and lower bilge keelsons form the foundation for the boiler saddles.

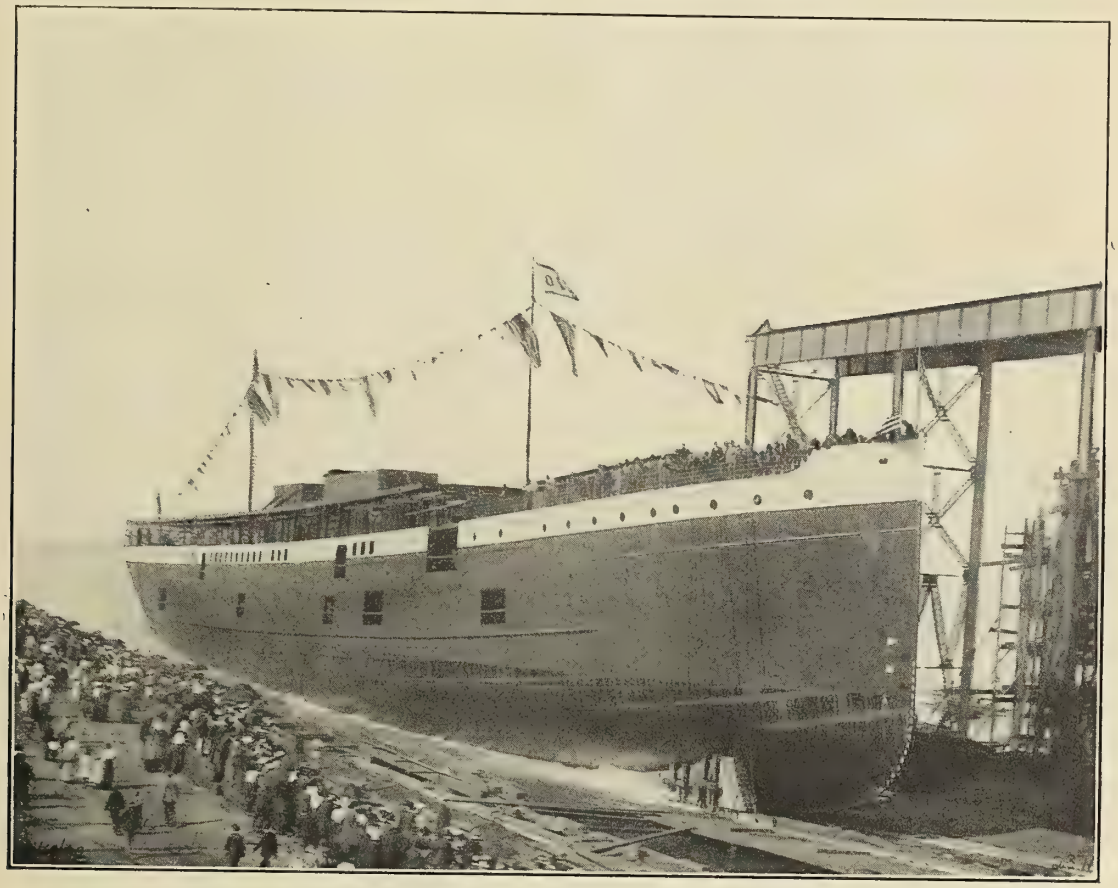
The shell plating is of the raised-and-sunken type with lapped butts and solid liners at frames in wake of outside strakes. The garboard strake is 26 pounds, bottom plating 24 pounds, bilge 27 pounds, side 22 pounds, main sheer 20 pounds, all plating being reduced at ends excepting around shaft boss. Doubling plates are fitted forward, from stem to aft of collision bulkhead, for protection against ice and from damage by

anchors. All lapped butts up to and including the main sheer are treble-riveted.

As previously stated, there are three principal decks and an orlop deck. All these have beams on alternate frames, the orlop deck having 11 1-2 by 5-inch by 35-pound bulb tee, the lower deck 12 by 3 9-16-inch by 31.83-pound channel, main deck 12 by 3 1-2-inch by 29.33-pound channel, and hurricane deck 8 by 3.4-inch by 23 1-2 pound channel. The shade deck has beams of 4 1-2 by 3-inch by 9.1-pound angles on alternate frames. The orlop deck has a 45-inch by 20-pound stringer, which runs continuous through boiler space, where it is 21 inches by 26 pounds. It is fitted with a calked deck of 4 by 6-inch yellow pine. In the after

scuppers discharging overboard. Solid stanchions are fitted for supporting all deck beams.

The hull is divided into four water-tight compartments by five thwartship water-tight bulkheads. These are located, as shown on plans, at the fore peak, in the fore hold, forward of coal bunker, aft of engine room, and at the after peak. The peak bulkheads extend to main deck and the others to lower deck. In addition there are three steel bulkheads dividing the coal bunkers and engine and boiler spaces. The bunkers are located at each end of the boiler room and extend to the lower deck, from which they are filled through scuttles. The coal capacity is 247.5 gross tons on a stowage basis of 45 cubic feet to the ton.



LAUNCHING OF STEAMER MONROE AT NEWPORT NEWS, VA.

hold it forms the top of the shaft alley and also the top of the fresh-water tanks built on each side of the shaft alley just forward of the after-peak bulkhead. The lower deck is a complete steel deck with stringer 45 inches by 20 pounds, and 14-pound plating covered with a calked deck of 5 by 3-inch yellow pine. The main deck is also a complete steel deck with stringer 60 inches by 24 pounds, and 15-pound plating with a 3 3-4 by 3 3-4-inch yellow-pine calked deck. The hurricane deck is calked from stem to passenger accommodations; from there aft it is a white-pine deck canvased. The orlop and lower decks have waterways throughout, with scuppers to bilge. The main deck has a waterway forward of passenger accommodations and the hurricane deck has a waterway throughout, both fitted with

The engine and boiler casings are steel throughout, extending to the top of the shade deck house. The enclosures for the firemen's quarters and the firemen's and crew's mess rooms are also steel.

The fresh-water capacity is about 25,000 gallons, of which part is in the tank built in the after hold and the remainder in two tanks located in the engine room.

PASSENGER ACCOMMODATIONS.

The passenger accommodations of the *Monroe* form one of the principal features of the ship. For the first-class passengers 61 state rooms are provided on the main deck aft of the machinery space and on the hurricane deck, while 11 state rooms for first-class colored passengers are provided on the shade deck. There are also

accommodations for 54 second-class passengers, 78 steerage, and for 82 officers and crew.

The houses enclosing the state rooms on the hurricane and shade decks, as well as all outside woodwork, are paneled white pine. The interior of all passenger state rooms is finished in white pine painted white, and the rooms are fitted with two enameled iron berths each, the upper berth being arranged to fold up when not in use. Wide transom seats upholstered with hair cushions are fitted in nearly all state rooms, and all rooms have white enameled lavatories with water tank and receiver, cherry toilet racks, and cherry-framed mirrors. The state rooms on the main deck are fitted in groups of four, with alcoves between groups. The inner rooms are lighted through fanlights from the hurricane deck, and the outside rooms and alcoves by 16-inch air ports. Several of the outside rooms have connecting doors for party use.

The main saloon, alcoves, and all parts of the passenger accommodations aft, excepting the interior of the rooms, are finished in paneled mahogany.

Entrance to the main saloon on the main deck is from passages on each side abreast of the engine casing, through large sliding doors. Entering these the first thing to strike the eye is the main stairway leading to the social hall on the hurricane deck. This stairway, in conformity with the other joiner work, is paneled in mahogany, with open balustrade, the newels being crowned with fine electric clusters. The steps are covered with rubber treads with brass nose and toe plates.

At the landing of the stairs is the builder's nameplate, and directly above, in place of the conventional mirror, is a large life-size oil painting of President Monroe, representing him sitting at a desk with manuscript in hand. The painting was made by T. Jaensen and is a fine piece of art.

Directly above the main stairway is a large well, finished in white and gold, which is lighted by a skylight with a leaded glass dome below. The panels of the latter have green wreaths entwined with mauve ribbons on an opalescent background, the whole effect being very pleasing to the eye.

At the foot of the main stairway on the starboard side is the purser's office and state room, fitted with desk, sofa, rolling berth, etc., and finished in paneled quartered oak. Directly opposite is a large special state room fitted with a full-sized brass bed and a porcelain lavatory with running water. Opening from this room is a private bath room with solid porcelain tub with nickel-plated shower and fittings. The tub is set in porcelain tiling set in cement, and the sides of the room from deck to deck are covered with white tiling. The bath room is also connected to the two state rooms aft of it.

Wide transom seats upholstered with hair are placed in the main saloon and social hall, and when necessary could be used for berths. Bookcases are built in the joiner work on each side of main saloon. In addition to the lights from the air ports in the alcoves, the saloon is lighted through two wells in the hurricane deck.

The care which the Old Dominion Steamship Company takes of the comfort of its patrons is evidenced by the manner in which the *Monroe* is fitted, both in general and in detail. Although passengers on any single run are on the ship only a matter of about eighteen hours and such things are unusual on short-route ships, the *Monroe* is supplied with two bath rooms, one for men and one for women. These rooms are at the after end of the main saloon and are furnished with solid porcelain tubs with nickel-plated showers and fittings, lavatories, and all appurtenances of first-class bath rooms. Like the private bath, these rooms have tiled floors and side walls. Aft of the bath rooms are the main first-class toilets, which, like all other toilet rooms for first-class passengers, have tiled floors and a tile wainscoting four feet high. They have two porcelain lavatories each, with all first-class plumbing requisites.

The social hall and saloon on the hurricane deck is finished similar to that on the main deck. It is entered from deck at forward end through large sliding doors with storm doors outside, and entrance is also provided through passages at after end.

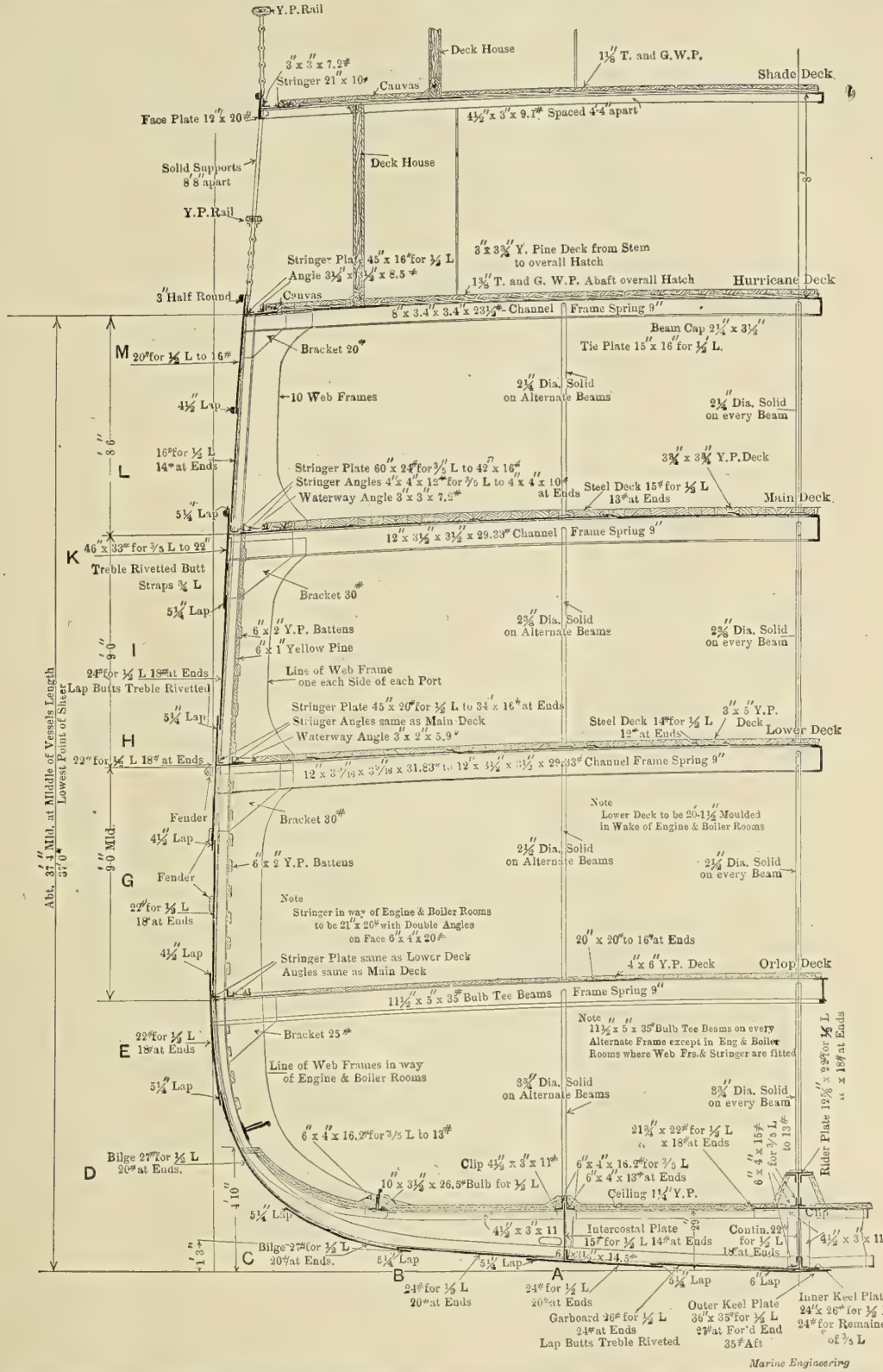
The saloons, alcoves, etc., are covered with Royal Wilton carpets, and rugs are provided for all state rooms. The predominating color of all furnishings is dark green.

At the after end the upper saloon is lighted by a fine mahogany skylight, which also lights the lower saloon through one of the light wells before mentioned. The sashes are fitted with lifting gear, thus providing means of ventilating the saloon.

Rising from the social hall about the middle of its length is a mahogany stairway which leads to the observation room on the shade deck. This room is a commodious one of paneled joiner work finished in white and gold, and is provided with upholstered transom seat, comfortable chairs, and a piano at the forward end. Over the stairway is a dome of joiner work with ornamental figured-glass panels. This room will doubtless be a favorite one in stormy weather for passengers who prefer being indoors. It is entered from the shade deck through mahogany sliding doors with glass panels in upper sash, and so it is easily accessible to a fine promenade, the shade deck from there aft being very open and clear. For those who prefer the open air there is plenty of space for promenading, the shade deck aft of the observation room and forward around the pilot house being thus available, while the hurricane deck from the foremast aft forms a splendid promenade at sides of houses and aft.

At the forward end of the hurricane-deck house is the first-class dining room, which extends the width of the house and has accommodations for 114 people. The interior woodwork is paneled white pine finished in white and gold, and the deck is covered with interlocking rubber tiling. In addition to a large number of windows on three sides, it is lighted through a well with a ribbed glass skylight above and leaded glass dome below. The well and the whole dining room are plentifully supplied with electric fixtures finished in Neptune green and when lighted at night present a very fine appearance. They were furnished by Page Bros., of Boston. The fittings in the dining room are all mahogany. At the after end of the dining room is a large mahogany sideboard with marble top and mirrors above. It is arranged with an ice box, and chill chamber for use as a wine locker. Six large electric fans are located in different parts of the dining saloon to provide additional ventilation. The room is entered by sliding doors on each side at the

forward end and by an inside passage from the saloon on the starboard side. This passage leads between the gold. A small skylight gives light and air to this passage. The steward's room is at the forward end just


Y.P.Rail
Deck House
3" x 3" x 7.2# Stringer 21" x 10#
Canvas
1⅛" T. and G.W.P.
Shade Deck
Face Plate 12" x 20#
4½" x 3" x 9.1# Spaced 4'-4" apart
Solid Supports 8'-8" apart
Deck House
Y.P.Rail
Stringer Plate 45" x 16" for ½ L
Angle 3½" x 3½" x 8.5#
3" x 3¾" Y. Pine Deck from Stem to overall Hatch
1⅜" T. and G. W.P. Abaft overall Hatch
Hurricane Deck
3" Half Round
Canvas
8" x 3.4" x 3.4" x 23½# Channel
Frame Spring 9"
Beam Cap 2¼" x 3½"
Tie Plate 15" x 16" for ½ L.
M 20# for ⅛ L to 16#
Bracket 20#
10 Web Frames
2¼" Dia. Solid on Alternate Beams
2¼" Dia. Solid on every Beam
4½" Lap
16# for ⅛ L 14# at Ends
L
Stringer Plate 60" x 24# for ⅜ L to 42" x 16#
Stringer Angles 4" x 4" x 12# for ⅜ L to 4" x 4" x 10# at Ends
Waterway Angle 3" x 3" x 7.5#
Steel Deck 15# for ⅛ L 13# at Ends
3¾" x 3¾" Y.P.Deck
Main Deck
5¼" Lap
12" x 3½" x 3½" x 29.33# Channel
Frame Spriug 9"
K 46" x 33# for ⅓ L to 22"
Treble Rivetted Butt Straps ⅜ L
Bracket 30#
5¼" Lap
2⅜" Dia. Solid on Alternate Beams
2⅜" Dia. Solid on every Beam
6" x 2" Y.P. Battens
6" x 1" Yellow Pine
I
24# for ⅛ L 18# at Ends
Lap Butts Treble Rivetted
Line of Web Frame one each Side of each Port
Stringer Plate 45" x 20# for ⅛ L to 34" x 16# at Ends
Stringer Angles same as Main Deck
Waterway Angle 3" x 2" x 5.9#
5¼" Lap
3" x 5" Y.P. Deck
Steel Deck 14# for ⅛ L 12# at Ends
Lower Deck
H
22# for ⅛ L 18# at Ends
12" x 3⅞" x 3⅞" x 31.83# to 12" x 3½" x 3½" x 29.83# Channel Frame Spring 9"
Abt. 37'-4" Mld. at Middle of Vessels Length
Lowest Point of Sheer 37'-0"
Fender
Bracket 30#
Note Lower Deck to be 20-1½" Moulded in Wake of Engine & Boiler Rooms
4½" Lap
2½" Dia. Solid on Alternate Beams
2½" Dia. Solid on every Beam
6" x 2" Y.P. Battens
G
Fender
Note Stringer in way of Engine & Boiler Rooms to be 21" x 20# with Double Angles on Face 6" x 4" x 20#
22# for ⅛ L 18# at Ends
20" x 20" to 16" at Ends
4½" Lap
Stringer Plate same as Lower Deck
Angles same as Main Deck
4" x 6" Y.P. Deck
Orlop Deck
11½" x 5" x 35# Bulb Tee Beams
Frame Spring 9"
Note 11½" x 5" x 35# Bulb Tee Beams on every Alternate Frame except in Eng & Boiler Rooms where Web Frs. & Stringer are fitted
22# for ⅛ L 18# at Ends
E
Bracket 25#
Line of Web Frames in way of Engine & Boiler Rooms
5¼" Lap
3¾" Dia. Solid on Alternate Beams
3¾" Dia. Solid on every Beam
6" x 4" x 16.2# for ⅗ L to 13#
21¾" x 22# for ⅛ L " x 18# at Ends
6" x 4" x 15# for ⅗ L to 13#
Rider Plate 19⅝" x 24# for ⅛ L " x 18# at Ends
Bilge 27# for ⅛ L 20# at Ends.
D
Clip 4½" x 3" x 11#
10" x 3½" x 26.5# Bulb for ⅛ L
6" x 4" x 16.2# for ⅗ L
6" x 4" x 13# at Ends
Ceiling 1¼" Y.P.
Clip
5¼" Lap
4½" x 3" x 11
Intercostal Plate 15# for ⅛ L 14# at Ends
Contin. 22# for ⅛ L 18# at Ends
4½" x 3" x 11#
Bilge 27# for ⅛ L 20# at Ends.
C
5¼" Lap
5¼" Lap
B
A
24# for ⅛ L 20# at Ends
24# for ⅛ L 20# at Ends
5¼" Lap
6" Lap
Garboard 26# for ⅛ L 24# at Ends
Lap Butts Treble Riveted
Outer Keel Plate 36" x 35# for ⅛ L 27# at For'd End 35# Aft
Inner Keel Plate 24" x 26# for ⅛ L 24# for Remained of ⅓ L
Marine Engineering

MIDSHIP SECTION OF THE STEAMER MONROE, BUILT BY THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

machinery casings and a row of state rooms, is paneled similar to the saloons, and is finished in white and aft of the dining room. It is finished with high wainscoting of oak and fitted with oak desk, rolling berth,

etc. A toilet room for women is located at the after end of the inside passage.

Aft of the dining room on the port side is the first-class pantry, which extends the full length of the boiler casing and is fitted with a large refrigerator, steam table, three urns, two porcelain sinks, silver locker, etc., all wood fittings of mahogany. The deck is covered with interlocking rubber tiling. A large dumbwaiter is fitted at the after end of the pantry, with shaft extending from main to shade decks. The galley is located on the main deck between the engine and boiler casings, and all food to the dining rooms and mess room is transferred by the dumbwaiter. Fittings in the galley comprise a large range, vegetable kettle, broiler, sink, etc. The floor is covered with brick set in cement. A light and air well is located over the range and has hinged covers with deadlights, the covers being provided with suitable lifting gear.

Abreast of the engine casing on the starboard side is a large ice house in three sections. It is insulated with double thickness of sheet cork, T and G pine, and paper, and has a storage capacity of seven tons of ice. The galley store room is located on the port side just forward of the galley.

On each side of the galley is a stairway leading to an athwartship passage on the hurricane deck. Opening from this passage on the after side is the officers' mess room, with a seating capacity of 14, which is also accessible from the fore-and-aft passage, deck, and engine room. It is finished in paneled joiner work with a wainscoting and deck of oak, and all fittings are oak.

On the starboard side of the mess room leading from the athwartship passage, a mahogany stairway leads up to a dining room on the shade deck which is used for first-class colored passengers. This dining room extends the full width of the shade-deck house and is finished and furnished similarly to the main dining room. A dome of joiner work with ornamental glass is fitted similar to that over the observation room.

As previously stated, the state rooms on the shade deck are reserved for colored passengers, accommodations for 21 persons being provided. On the starboard side aft, a smoking room paneled in quartered oak is provided for their use. The deck in this room is covered with interlocking rubber tiling. The toilets are in all respects similar to the white passenger toilets. The shade deck abreast of these quarters is railed off for use as a promenade for colored passengers.

On the shade deck forward of the boiler casing is a fine, large, first-class smoking room, which is finished in paneled quartered oak and extends the width of the house. The deck is covered with interlocking rubber tiling. A skylight with leaded glass dome beneath adds much to the appearance of the room. An electric exhaust fan is fitted in the skylight for ventilating purposes. The smoking room is entered from the shade deck through sliding doors and from the hurricane deck by a large stairway leading from the fore-and-aft passage just aft of main dining room. A large toilet room, with fittings similar to the other toilets, is connected to the smoking room. In all the passenger accommodations all windows have mahogany frames and mahogany Venetian blinds, and all rooms opening on deck have mahogany Venetian doors. All sliding doors have glass sashes in upper panels and are fitted with storm doors.

Forward on the shade deck is a raised pilot house with bridge aft on level of top of deck house. The pilot house is finished in oak, with oak floor, and is fitted with all necessary navigating appliances. Aft of the pilot house, and connected to it by a small stairway, is the captain's room, which is finished in paneled quartered oak. This room is fitted with a brass bed, marble-top lavatory, quartered-oak desk and bookcase, lockers, drawers, etc. Quarters for the officers are also located on the shade deck aft of the captain's room, and are finished with high oak wainscoting.

Abreast of the officers' quarters, on each side of the ship, is a companionway with mahogany booby hatch and ladder leading to hurricane deck.

The chief engineer's room is on the port side of the hurricane deck abreast of the engine room, to which it is directly accessible. It is finished in paneled quartered oak, and fitted with rolling berth, desk, etc. The assistant engineers, oilers, and water-tenders are quartered on the main deck abreast of engine casing. An engineers' toilet is provided on this deck also, abreast of engine room.

Quarters for petty officers, cooks, and messmen are provided in six state rooms in a deck house on hurricane deck forward. All are fitted with enameled iron berths. Accommodations for 12 men are provided in the forecastle, for 18 firemen abreast of boiler casing on main deck, and for 21 waiters on the lower deck aft. These quarters are all fitted with metal stand berths and wire-mesh lockers. Separate toilets and wash rooms with showers are provided for the petty officers, crew, firemen, and waiters, the deck in all these toilets being covered with cement tile. Separate mess rooms for the crew and firemen are placed abreast of boiler casing on port side.

On the main deck aft of forecastle are steerage quarters for 42 men and 36 women. Each steerage has a wash room and toilet, the deck in these being covered with cement tile. Access to the steerage quarters is by oak stairways leading from the steerage cabin on the hurricane deck, this cabin being located in the forward end of hurricane deck house.

Aft of the steerage quarters, in a steel enclosure, are berths and space for 54 deck passengers. When not used for passengers this space may be used for cargo; companionways with steel booby hatches give access to it from the hurricane deck, and doors in the after bulkhead give access from main deck. The main deck aft of the deck-passenger space is provided with hammock hooks for use when carrying seamen between the New York and Norfolk Navy Yards. All quarters throughout the ship are supplied with steam heat.

Lamp and paint rooms are fitted abreast of deck-passenger space and divided from the latter by a passage with steel bulkheads.

FREIGHT SPACE.

Arrangements for handling and stowing freight on the *Monroe* are very complete. The lower hold space between orlop and lower decks is divided into three compartments, with large hatches to each. The main deck has one large hatch directly over No. 2 hatch in lower deck. No. 1 and No. 2 holds on lower deck are connected by two double-hinged water-tight doors for use in loading and unloading freight. The main hatch is

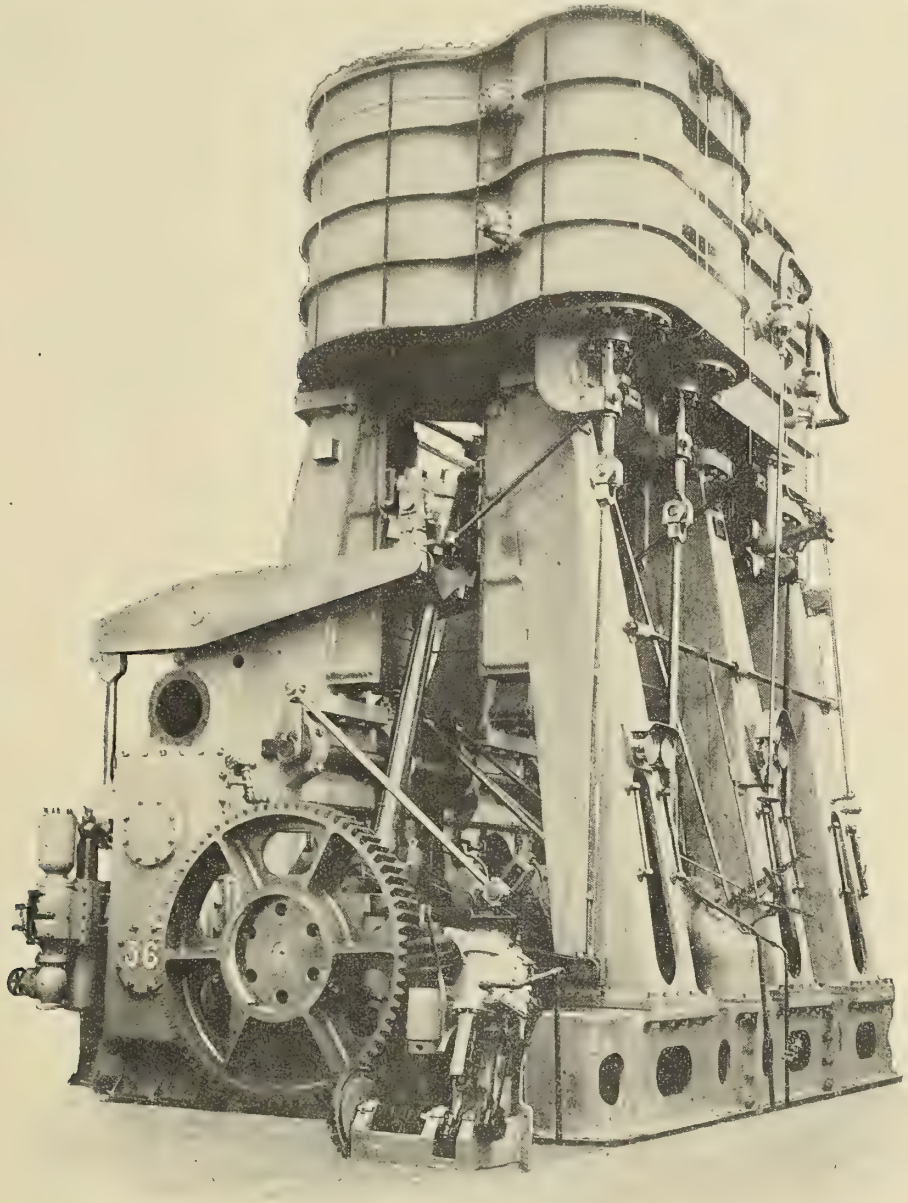
worked by two cargo cranes through two double-cylinder, 8 1-4 by 10-inch, single-drum Hyde winches. The hatches on the lower deck to the forward and after holds have each a double-drum winch, 6 1-4 by 8 inches, with cargo cranes for each drum.

In addition to the regular hatches, two hatches 8 by 7 feet are fitted in the forward hold and two aft in which steam freight elevators are placed. These elevators are operated separately by double 7 by 10-inch engines fitted with automatic stops. The elevators and gear were supplied by the Otis Elevator Company. Cargo cranes are also placed at each elevator hatch and are operated from the elevator engines.

The cargo ports for access to the lower deck are worthy of notice. Of these there are two 6 feet 3 inches by 9 feet and one 5 1-2 by 7 1-2 feet on each side. These ports are arranged to slide on an overhead track and are fitted with the usual arrangements for making water-tight. Each port has a small hinged door which is used in connection with opening the port, and can also be opened at sea in fair weather so as to provide additional ventilation to between-deck space.

In addition to the above ports, two coaling ports, 5 1-2 by 5 1-2 feet, are fitted on each side opposite the coal bunkers, thus making an easily-coaled ship. These ports are hinged in two sections and may also be used as freight ports.

On the main deck opposite the hatch is a large port with hinged door in sections; large hinged ports are also provided for handling baggage; and passenger gangways are provided in the passages forward of the main saloon. Two baggage rooms are located on this deck forward of the boiler casing and are enclosed with wire-mesh bulkheads arranged in panels to hinge up under



THREE-CYLINDER, TRIPLE-EXPANSION ENGINES FOR THE STEAMER MONROE, OF THE OLD DOMINION LINE.

the deck beams when not in use. This arrangement makes them available for cargo when desired. Arrangements are also made for carrying horses on the main deck when required, the stalls for this purpose being portable. Between the cargo ports and the passenger accommodations on this deck hinged steel shutters are fitted which provide ventilation to the cargo space and for the firemen's quarters. Twelve-inch side lights are fitted in each shutter.

The available cargo space of the *Monroe* is about 217,000 cubic feet, including the baggage room. This also includes the combustible store room aft of the engine casing on the lower deck, which is a steel enclosure for matches and cartridges. In the holds cargo battens are run on the frames; and 'tween decks the sides of the ship and machinery casings are close-ceiled, the latter being also insulated with magnesia.

In addition to the cowls provided for natural ventilation, a complete system of artificial ventilation is provided for the cargo space on lower deck, on which large quantities of vegetables and perishable goods are carried. This system consists of separate supply and exhaust fans, one set located on the main deck forward and the other on the shade deck aft, the discharge duct of the latter leading down through the passenger accommodations forward of the mainmast, with which it is encased. The ducts run under the main-deck beams on each side of ship, and the supply ducts have branches to ship's side every ten feet, these branches running between the ceiling and ship's side to within twelve inches of the lower deck. The ventilating fans are Sturtevant steel plate, 70 inches diameter, driven by electric motors.

DECK EQUIPMENT.

The deck equipment of the *Monroe* is very complete, comprising steam steering gear, steam windlass, capstans, etc. The steering engine is of the Sickles type, and is located on the main deck under the pilot house. The leads from the engine run under the hurricane deck to the passenger quarters, aft of which they run on top of deck to a large quadrant located above the hurricane deck. Auxiliary steering gear of the Napier type is also fitted on this deck.

A Hyde steam windlass is located on the hurricane deck forward of the windlass engine, which is double, 10 by 10 inch, being located on the main deck and driving the windlass through a vertical shaft. A capstan on the hurricane deck is also driven through gearing by the windlass engine. Aft of the quarters on the main deck is another capstan, with an 8 by 8-inch vertical engine.

Bower anchors of the Baldt cast-steel stockless type, 5,500 pounds each, are stowed in the hawse pipes, and 210 fathoms of 2-inch stud-link chain are stowed below.

Capacity for 365 persons has been provided for in nine 24-foot metallic lifeboats and four Carley liferafts. The boat davits are of the hinged type. There is a complete set of awnings on the hurricane deck forward, all around the shade deck, and on top of the shade-deck house over the officers' quarters and smoking room.

An 18-inch bell is fitted on the foremast.

Blake duplex pumps, 5 1-4 by 3 1-2 by 6 inches, with hand attachment, are fitted in the forecastle and on the main deck aft for use in washing decks, etc.

A large and fully-equipped electric plant is another of the *Monroe's* features. It consists of three 25-K. W., 125-volt General Electric generators, driven by Harrisburg Ideal single-cylinder, horizontal engines with cylinders 8 by 10 inches, all located in the lower engine room. The ship is wired for over 800 16 candle power lights, exclusive of electric running lights. An 18-inch searchlight is mounted on the foremast and is operated from the pilot house.

MACHINERY.

The main engine of the *Monroe* is of the direct-acting, inverted-cylinder, triple-expansion type with cylinders 33, 52, and 84 inches diameter, respectively, and 54 inches stroke. The high-pressure cylinder is fitted with a working liner, and all cylinders have piston valves, the high-pressure having one 13 inches diameter, the intermediate one 25 inches diameter, and the low-pressure two 25 inches diameter. All valves are located on the starboard side of the engine and are operated by radial gear of the Marshall type. All pistons are cast iron, with follower and spring rings. The piston rods are steel, 7 1-2 inches diameter, and are secured to pistons and crossheads by taper end with nuts. Crossheads are of forged steel, with double gudgeons 8 1-2 inches diameter by 9 1-2 inches, and are fitted with double cast-iron slippers lined with white metal. The connecting rods are forged steel, 122 inches between centers, with forked upper end, and taper from 7 to 8 3-4 inches diameter. Brass boxes are fitted for gudgeon and crank-pin bearings, the crank-pin boxes being also lined with white metal.

The cylinders are supported on cast-iron housings of box section, with slipper slides bolted to each. The front housings rest directly on the bed plate, and the back housings on the surface condenser, which is built into the engine framing.

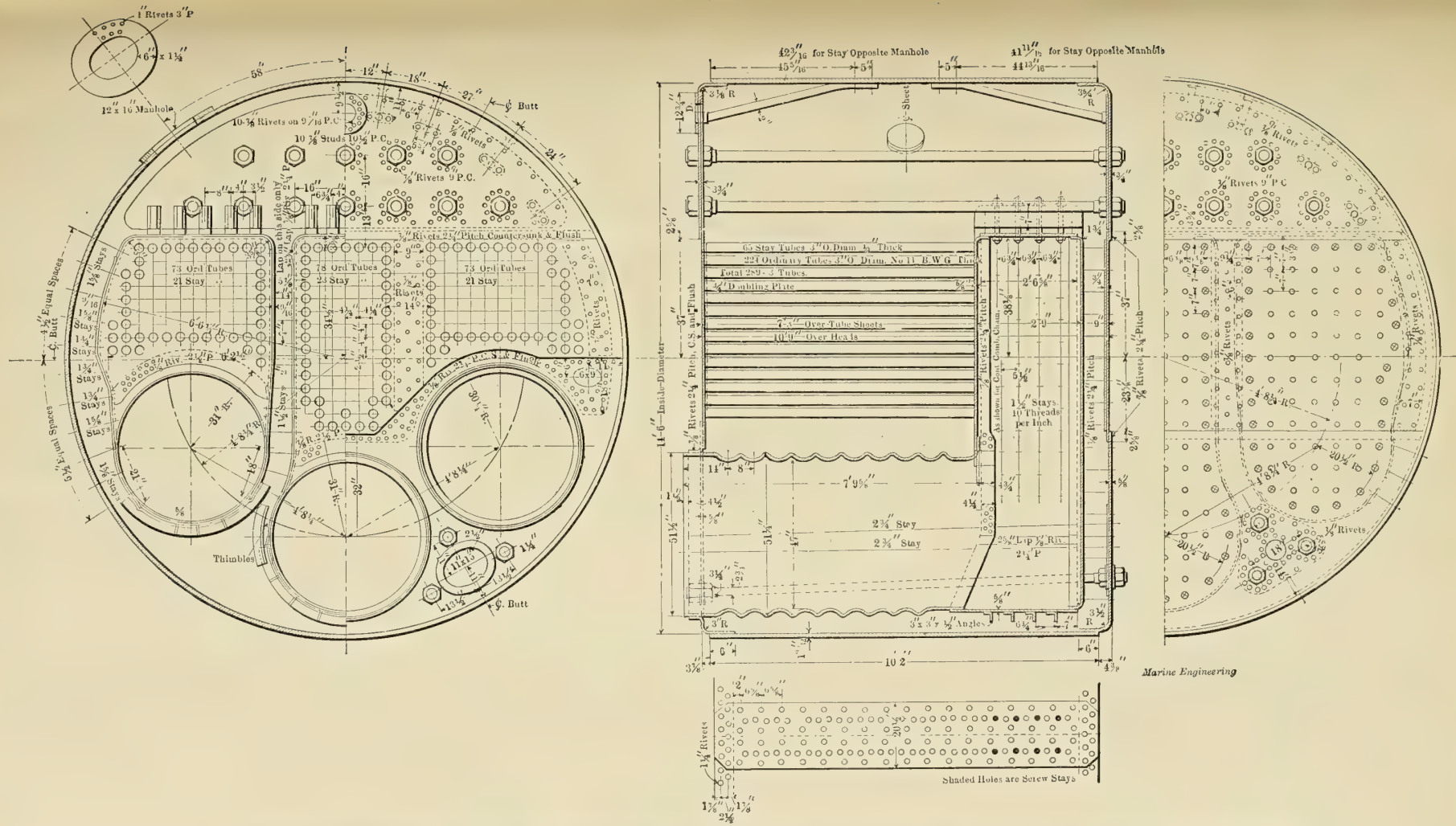
The bed plate is a deep box section of cast iron in three sections, and has five main bearings, three 17 3-4 inches long and two 29 1-2 inches long. These are fitted with cast-steel boxes lined with anti-friction metal, and have separate binders of wrought iron.

The crank shaft is forged steel, 16 inches diameter, of the built-up type, in two sections, with wrought-iron crank webs set at 120 degrees apart in the usual sequence; the crank pins are 16 inches diameter by 16 1-2 inches long. The thrust shaft is 15 1-2 inches diameter, with separate thrust collars for ahead and astern, eleven collars for the former and six for the latter, all being 23 1-2 inches diameter. The thrust is taken on white metal faces by cast-iron bearings of the full-ring type, the whole provided with water circulation.

All line shafts are 15 1-4 inches diameter and are supported on steady bearings located from 16 feet to 20 feet apart. The tail shaft is 17 inches diameter, brass-lined in stern-tube bearings. The latter are brass sleeves lined with lignum vitæ. The stern tube is cast iron.

A sectional four-bladed propeller with cast-iron hub and cast-steel blades is fitted. It has a diameter of 17 feet with 21 feet 6 inches pitch.

As previously stated, the condenser is built into the engine framing. It has a cooling surface of 7,280 square feet with 1,710 3-4-inch brass tubes. The circulating water enters at the bottom and discharges from the top. A centrifugal pump with 17-inch suction and discharge circulates water through the condenser and is driven by an 11 by 11-inch single-cylinder engine.


12" x 16" Manhole
10 3/8 Rivets on 9 7/16 P.C.
10 3/8 Studs 10 1/2 P.C.
7/8 Rivets 9 P.C.
3/4 Rivets 2 1/4 Pitch Countersunk & Flush
73 Ord. Tubes
21 Stay
78 Ord. Tubes
24 Stay
73 Ord. Tubes
21 Stay
Thimbles
Marine Engineering
62 Stay Tubes 3" O. Diam. 1/4" Thick
224 Ordinary Tubes 3" O. Diam. No 11 B.W.G. Thk
Total 289 - 3 Tubes.
4" Dumbling Plate
7 1/2" Over Tube Stoods
10 9" Over Heads
1 1/8" Stays 10 Threads per Inch
2 3/4" Stay
2 3/4" Stay
3 1/2 x 3 1/2 x 1/2 Angles
Shaded Holes are Screw Stays

ONE OF THE SIX 3-FURNACE SCOTCH RETURN TUBULAR BOILERS BUILT BY THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY FOR STEAMER MONROE.

The main air pump is 32 inches diameter by 25 inches stroke and is driven from the L. P. crosshead. Two 6 1-2-inch bilge pumps are also attached to the main engine. For the use of auxiliary machinery when in port an auxiliary condenser with 600 square feet of cooling surface has been provided. It is fitted with an independent centrifugal circulating pump with 8-inch suction and 7-inch discharge, driven by a single 5 by 6-inch engine. This pump is also connected to the main condenser for use in emergencies. Steam turning gear with a single-cylinder engine, 8 by 8 inches, fitted with link valve gear, is provided. It is located on the after engine-room bulkhead and operates through worm gearing.

With the exception of the air pump and attached bilge pump, all auxiliaries are independent. For feed pumps two Blake vertical simplex pumps, 14 by 10 by 18 inches, are fitted. All other pumps are Blake also and comprise an 8 by 7 by 12-inch horizontal duplex fire and bilge pump, one 4 1-2 by 2 by 4-inch horizontal duplex feed pump for donkey boiler, a 4 1-2 by 4 by 6-inch vertical simplex pump for fresh-water service, and an 8 by 8 by 12-inch vertical simplex sanitary pump.

BOILERS.

The boiler-room equipment consists of six Scotch

boilers arranged with their axes athwartship, thus making a fore-and-aft fire room. A vertical donkey boiler 6 feet in diameter by 11 feet high is located on the lower deck. Each main boiler is 14 feet 6 inches diameter by 10 feet 9 inches long, with a working pressure of 175 pounds. There are three 47-inch Morison furnaces in each boiler and 289 three-inch tubes, each furnace having its own combustion chamber. The total heating surface is 12,288 square feet and total grate surface 441 square feet. The boilers are fitted with dry pipes, internal feed pipes, all necessary stops, feed and blow-off valves. A Mossman circulator is fitted in the feed pipe of each boiler for circulating the water, and all boilers are connected to one main elliptical stack.

For ventilating the fire rooms four 36-inch cowl ventilators are provided, and in addition there are two steam-driven Sturtevant fans to assist the natural ventilation. These fans are located near the top of the fidley and draw air through the open gratings above, discharging through the regular ventilating ducts. The fans are 54 inches diameter with 19-inch tip, and are driven by compound single-acting engines 5 1-2 by 10 by 5 1-2 inches.

From stem to stern the *Monroe* is a well-built and finely-finished ship, complete in all particulars, and ably sustains the reputation of the Atlantic coast for having as fine a fleet of passenger and freight steamers as can be found the world over.

Name—Monroe.	Nationality—American.	Type—Coasting passenger and freight.	
Launched—1902.	Builder—Newport News S. B. & D. Company.	Owner—Old Dominion Steamship Company.	
Length over all	366 ft.	Shafting, crank and pins diam.	16 ins.
" between perps	344 "	" thrust	15 1-2 ins.
Beam molded	46 "	" collars	23 1-2 "
Depth to hurricane deck at lowest point of sheer	37 "	11 collars for ahead; 6 collars for astern line	15 1-4 ins.
Depth to main deck	28 " 6 ins.	" tail	17 "
" " lower "	19 " 6 "	Condens. surf	7,280 sq. ft.
" " orlop "	10 " 6 "	Tubes	1,710 3-4-in.
Block coefficient	.66	Auxiliary condens	600 sq. ft.
Prismatic "	.703	Air pump, D. C.	32 ins diam. by 28 ins.
Midship "	.93	Feed pumps	2 simplex, 14 by 10 by 18 ins.
Displacement at 18 ft	5,375 tons	Electric light plant	3 25 K. W. single
Cargo space	217,000 cu. ft.	**Propeller**	8 by 10-inch engines
Coal capacity	247.5 tons	Diam	cast-iron hub, 4 steel blades 17 ft.
Engines: Type	single, triple-expansion	Pitch	21 ft. 6 ins.
Cylinders, diam	33, 52, 84 ins.	**Boilers:** number	6 S. E. Scotch
Stroke	54 "	Diam	14 ft 6 ins.
Valves	all piston; H. P. 13 ins.; M. P. 25 ins.; two L. P. 25 ins.	Length	10 " 9 "
		Pressure	175 lbs.
Gear	Marshall radial	Furnaces	3 Morison in each
Piston rods, diam	7 1-2 ins.	Diam	47 ins.
Connect. rods, length between centers	122 "	Tubes, each boiler	289 3-inch
Connect. rods, diam	7 ins. to 8 3-4 "	H. S. total	12,288 sq. ft.
		G. S. total	441 " "

USES OF ELECTRICITY ON BOARD SHIP.—II.

BY J. W. KELLOGG.

CARE OF GENERATORS.

In electric-generating sets troubles are usually due to the engine driving the set rather than to the generator. In a well-constructed generator there is very little to get out of order. With the conservative heat ratings that are given with all first-class machines to-day it is practically impossible to so overload the machines as to cause burn-outs. The principal troubles from overloads will be more on the commutator, through sparking and troubles with the brushes, than from any liability of burn-outs. The armature should be protected from any oil or dirt getting into the winding. Oil is very injurious, not only to the insulation on the armatures, but to all insulation on the conductors as well.

With the carbon brush, which is used universally at this time, there is very little care required in the setting of the brushes. A machine that operates properly will soon get a perfect glaze on the commutator, and there will then be very little wear to either commutator or brushes. A piece of sandpaper fastened around the commutator will shape the brushes so as to make them fit the commutator perfectly in a very few minutes.

There are sometimes troubles in getting a generator to build up after it has stood for a long time and the magnetism has left the fields. It is then necessary to excite the fields from a separate source of power. In starting up a machine, if there is trouble in getting the machine to build up, see that the brushes are in good contact with the commutator and that all the connections of the machine are well made. Only in very exceptional cases will it be found impossible to get current from the machine if there is no external resistance in the field circuit.

CURRENT, WIRING, AND INSULATION.

On generators and motors, and practically all appliances furnished for use on shipboard at the present day, such parts as are liable to corrosion—bolts, nuts, screws, washers, and exposed parts in the wiring appliances—are made of non-corrosive metal. Safety appliances, such as circuit breakers and fuses, are installed at convenient points, so that in case of overloading of any conductors the safety appliances will operate, thus eliminating the danger from fire. The underwriters' rules and practice of all reliable concerns to-day insure the installation of electric plants in such a way as to render fire risk practically nothing.

The original voltage used was in the neighborhood of 50, which, in a measure, accounts for the absence of trouble due to poor insulation of the wires. The voltage for the navy was afterward changed to 65 and a little later to 80, a board having been appointed and adopted this voltage as one being generally used by different governments. With the increasing size of installations and the corresponding increased current to be carried, it has been found impracticable to use as low a pressure as 80 volts, and on the first plants where a large number of auxiliaries were to be operated by electric motors the mains for the power circuits were run on the three-wire system and the motors wound for 160 volts. The incandescent lamps were still operated on the 80-volt circuits.

A short time ago the Navy Department changed the standard voltage to 125, and the motors and lights are all operated at this voltage. For merchant ships the voltage for lighting has been established at 110 for some years; and now that the use of electric motors is growing, motors are being installed to operate on the three-wire system at 220 volts. Machines used at the present time are all direct-current compound wound, designed to operate at 300 to 500 revolutions a minute.

STEAM TURBINE.

The alternating-current motor is well adapted for use on shipboard, and it is believed that in the near future alternating-current installations will be made on account of the simplicity of the induction motor. The use of the steam turbine will tend to bring this about, as the design of electric machines for direct connection to steam turbines can be best undertaken by the use of alternating-current machines. The steam turbine is ideal for ship work; it has the advantages of freedom from vibration, high efficiency under all conditions of load, light weight, possibility of using high pressure of steam, and freedom from wear owing to the lack of reciprocating parts. At the present time the developments in this class of apparatus are so rapid it seems certain that in the near future the turbine-driven sets will be universally used for the electric plants on board ships, from which power can be taken and distributed to electric motors on all sorts of auxiliaries. The advantages over the steam engine are very great, and it is hard to find any disadvantages.

CURRENT DISTRIBUTION.

The circuits from the main generators are generally carried to a switchboard conveniently placed, usually in the dynamo room, and from there through switches and cut-outs or circuit breakers to the different parts of the ship. It is customary, in plants used primarily for lighting, to run mains from the switchboard to two or three distributing points on the ship where a panel is installed in a lead-lined box, while in some cases, where it is not damp, the box is asbestos-lined. Circuits of from eight to ten lights even are led off from the main through switches and cut-outs mounted on these panels. This makes practically a fire-proof junction point, and with this subdivision of the lights the dangers from faulty circuits are minimized. These distributing boards are usually placed in some passageway where the switch can be reached without interfering with the passengers, and where they are not exposed to interference by people who are not authorized to handle them.

SINGLE- AND DOUBLE-WIRE CIRCUITS.

In most of the freight steamers built in England single-wire systems of distribution are employed. In some ships of the American Line in this country it is used, but generally the two-wire system is the one employed. In the single-wire system the hull of the ship is used for the return of the current. It is claimed for this that any defects that develop are more easily located and remedied, that it is only necessary to keep one circuit free from grounds and in good order, while but one-half the copper is required.

It has always been the belief of most engineers in this country that the single-wire system might give trouble from faulty contacts in the return circuit; if there were not perfect electric connection between the plates of the hull of the vessel, corrosion might take place at all joints. It is probable that in the plants that have already been installed the uses of the current have been limited to lighting and that no very large amount has been carried, in which case no faults should be expected to develop. With the use of very large motors for the auxiliaries and handling the winches, windlass, and steering gear, where very large power is distributed, it would be necessary to have the metallic circuit for return perfect and sufficiently large to carry the current. In one of the latest installations on a large ocean freight and passenger-carrying steamer, circuits of 1,000,000 circular mils cables are being installed, and it is expected that there may be rushes of current up to 2,000 amperes.*

In the two-wire system the mains are carried to all outlets and the flow of the current is confined entirely to the copper wires themselves, which are both insulated and kept entirely separate from the hull of the vessel. Double pole switches and cut-outs are installed, and any excess current in either wire of the system at any point will be taken care of.

It is customary to install the circuits on the ship so that each individual circuit has an insulation resistance of at least one megohm. The insulation, when all the circuits of the machine are connected, should not show less than 100,000 ohms, and in most cases it will be very much higher. Grounds are usually located by means of lamps on the switchboard which have a connection to the ground and to either side of the circuit. Thus, when there is a ground the lamps burn dimly or brightly, according to the side on which it occurs.

THREE-WIRE CIRCUIT.

When it is desired to operate the lights on a low-voltage circuit and the motors at a higher voltage on account of the large currents that have to be handled in the conductors, on the commutator, and on the controlling appliances, the three-wire system is often employed, in which the voltage between the two outside wires is double that between either outside and intermediate wire. The lights can be carried on circuits connected to either of the outside wires and the middle wire, and the motors on circuits to the two outside wires. The generators are wound for the low voltage; the circuits are carried to them in such a way that the two outside wires are run from positive side on one machine and negative on the other, the middle wire being connected to the other positive and negative terminal of each machine. The two generators are thus operated in series, and the current on the outside wires will be at a voltage double that of each machine.

In some cases, principally on naval vessels, where it is desired to have the additional precaution of two sources of supply in case of failure of any circuit, a double set of wires is run to some distribution point, usually on opposite sides of the vessel. A switch is placed at some convenient point in the circuit in such a way that current can be fed through the distribution point from either set of mains.

*A circular mil is the measurement of cross-sectional area of a wire; a wire .1 inch diameter having 10,000 c. m., one of .2 inch diameter having 40,000 c. m., etc.

For running lights, such as the masthead, side lights, and towing lights, where it is essential that the light burn continuously for certain hours, it is common practice to install two lights in each lantern, with a set of three-wire mains running from an indicator in the pilot house to each light, the switch on the indicator in the pilot house being so arranged that it can be shifted between the middle wire and either of the outside wires. When the lamp that is connected on one side is burned out the switch is simply thrown over to the wires connecting the other lights. The failure of either light is indicated by a buzzer or pilot light in the pilot house.

SIZE AND LOCATION OF WIRES.

The determination of the size of the wires for ship work is usually done from the Underwriters' Tables, which give a safe carrying capacity for each size wire. The distances are usually so short that a wire of sufficient size to carry the current in compliance with these rules is large enough to take care of any drop in the circuit. From 2 to 3 volts drop from the dynamos to the furthest lamp is allowed, and the variation of voltages on any lamps should not be over 2 to 3 per cent. In case the distance is so great that the drop has to be taken into consideration, the size of the wire is determined as follows for direct-current installations:

$$CM = \frac{L \times C \times 10.8}{\text{Volt loss in line}}.$$

L = total length of wire used. C = current in amperes.

The mains are usually led along the passages on the main deck; if in pipes, under the beams; and if through insulators, the beams are drilled and the wires led up close to the deck. This is generally found to be a location where there is the least exposure to mechanical injury or injuries from any causes, such as heat and moisture. Wires are not led through the freight spaces and it is not desirable to lead them through engine and boiler rooms; they can be located on the fore and aft bulkheads on the main passageways without cutting through water-tight compartments or main bulkheads.

(To be continued.)

Pacific Cable Completed.

On July 4 President Roosevelt sent a telegram to Governor Taft at Manila over the new Pacific cable laid by the Commercial Cable Company. The message was sent from Oyster Bay late at night and was as follows:

Governor Taft, Manila:

I open the American-Pacific cable with greetings to you and the people of the Philippines.

Theodore Roosevelt.

The route of this cable extends from San Francisco to Honolulu, 2,276 miles, which was opened on December 26 last year, and which was described in Marine Engineering, February, 1903. The next stretch is to Midway Island, 1,256 miles; the third stretch is from the Midway Island to Guam, 2,593 miles; while the fourth section is 1,490 miles, from Guam to Luzon in the Philippines. The connecting link was made at Honolulu by splicing the western cable with the eastern section. Thus was completed the transpacific, all-American cable.

13,000-ton Battleships.

The sketch plans of the 13,000-ton battleships *Idaho* and *Mississippi* have been approved by the Secretary of the Navy. The general dimensions of each will be: length, 375 feet; breadth, 77 feet; mean draft, 24 feet 6 inches; indicated horse power, 10,000; and trial speed of from 16 1-2 to 17 knots. In submitting the plans the Board of Construction informed Secretary Moody that it had concluded that the "intent of the act would be best complied with, and the interest of the navy furthered under this act, by retaining for the vessels in question as nearly as possible the offensive and defensive features of the first-class battleships, and reducing the speed and power and the coal to be carried on trial to the amount necessary, in order that the trial displacement of 13,000 tons may not be exceeded."

To this decision Rear-Admiral Melville, Engineer-in-Chief, while signing the board's report of plans, took some exception. "While these vessels will undoubtedly be quite efficient," he wrote, "they would in my opinion be very much more so if given more speed, since I do not consider that a very heavy battery, comparatively low-sized and small coal capacity, with only nine inches of side armor, make the best possible combination. The displacement being limited to 13,000 tons makes it difficult, if not impossible, to produce a thoroughly satisfactory and up-to-date battleship."

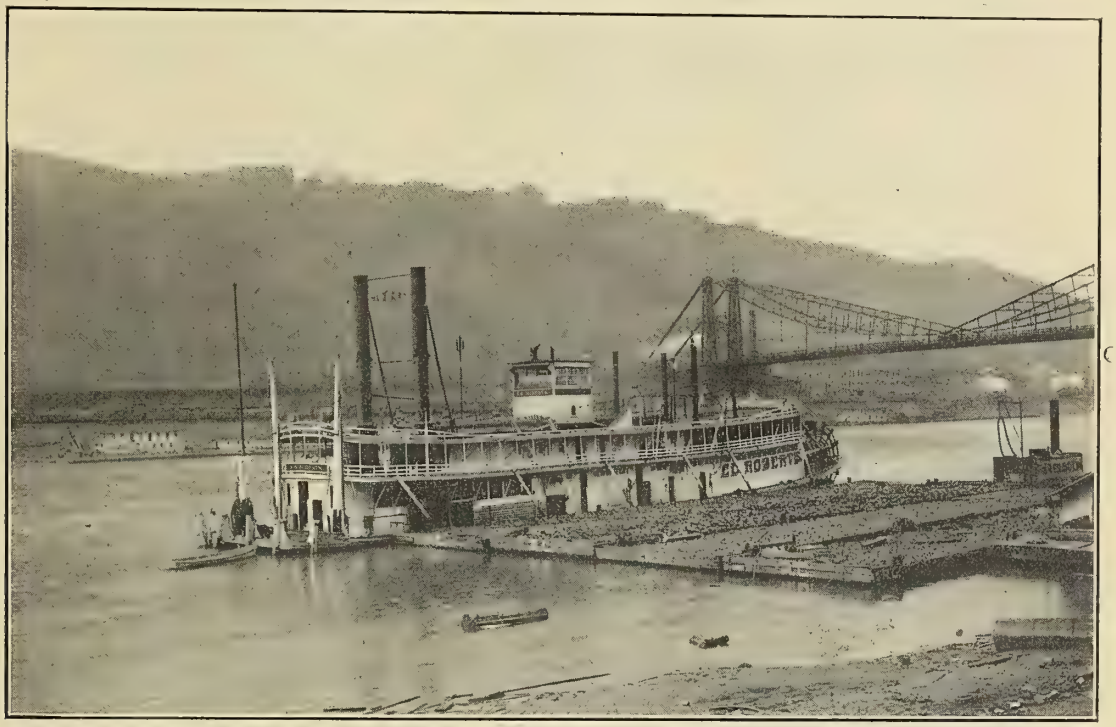
Each vessel will have a battery of four 12-inch, eight 8-inch, ten 7-inch, and twelve 3-inch breech-loading rifles, and twenty other smaller guns. The armor protection will consist of a water-line belt of 9 inches, tapering to 7 inches at the bottom and to 7.5 and 4 inches at the ends, 7-inch casemate athwartship armor, 12 inches and 8 inches on the main turrets, 10, 7 1-2, and 6 inches on the main barbettes, and 9 inches on the conning tower.

In explanation of the principal features of the *Idaho* and the *Mississippi*, the board compares these vessels with those of the *Connecticut* class, which are to be 16,000-ton battleships. They will have, as regards armament, the same main battery, excepting only a reduction in the number of 7-inch guns from twelve to ten. Owing to the reduction in length from 450 feet to 375 feet, the secondary battery is somewhat less than the *Connecticut's*, the principal differences being in the reduction from twenty to twelve 3-inch and twelve to six 3-pounder guns. Part of the reduction in the secondary battery is due to the fact that in order to secure the heavy main battery and corresponding section of a first-class battleship it is necessary to omit the after military mast and to reduce the freeboard aft, as on the *Maine* class. It is accordingly not intended to fit these vessels as flagships.

The weight given to armor protection will be 3,377 tons, or 25.9 per cent. of the trial displacement, as against 3,992 tons and 24.9 per cent. for the *Connecticut*. The horse power of the main engines will be 10,000 against 16,500. The board is of the opinion that in working out the final designs this power will provide a maximum trial speed of 17 knots. Although the full coal capacity will be about 1,750 tons, as against 2,200 in the case of the *Connecticut*, its endurance is estimated at about 5,750 knots, as against about 5,300 for the *Connecticut*, at ten knots under ordinary conditions.

Towboats on Western Rivers.

The modern Western river towboat, such as is built on the Ohio and Mississippi, handles more tonnage and draws less water, it is claimed, than any other boat in the world. Here, in a single shipment, a towboat of about 175 feet in length will handle 50,000 tons of coal in barges down the Mississippi. The coal is mined in the hills of western Pennsylvania and carried to the markets of Cincinnati, Louisville, Memphis, and New Orleans. The Monongahela River Consolidated Coal and Coke Company, which controls the shipment of river coal from Pittsburg, and which owns between 75 and 80 steamers, as well as 20 to 30 tugs, transports each year no less than 150,000,000 bushels of coal.



OHIO RIVER STEAMER ED. ROBERTS AND COAL BARGES AT PITTSBURG.

The steamers of this company are divided into four classes. In the first are those plying between Pittsburg or Louisville and New Orleans, the former course being not less than 2,000 miles; the second class of steamers take coal only as far south as Louisville; the third class tow the barges down as far as Cincinnati; while the fourth class comprise the smallest steamers, used in bringing the tows from the loading points on the Monongahela river to Pittsburg harbor, where they are prepared for shipment to the South.

Some of the vessels of the present fleet have been in active service for more than thirty years, and navigating these streams requires most skilled piloting. The compass is not used, the pilots steering their boats according to sights on the shore, and run by day and night.

As the rivermen have to depend entirely upon freshets to start the coal shipments from the Pittsburg district, the boating season only lasts from six to seven months, starting in the late fall and lasting until early summer. During the first week of July of the present year the fleets were favored with high water and no less than 50 towboats started down from Pittsburg, their fleets aggregating 10,000,000 bushels of coal. The fleets made up at Pittsburg consist of 10 to 20 craft, coalboats and barges, and one or two fuel flats for supplying the towboat with fuel. When the large boats reach Cincinnati and Louisville the size of the tows is doubled. On the return trip on the Ohio the towboats bring back from 20 to 25 empties, making from 3 1-2 to 4 miles an hour upstream. The downstream speed with the current is from 5 to 6 miles, but the speed, both up and down stream, is dependent upon the water in the river. If the water is at low stage the speed must be slow, to avoid accident.

At some points in the rivers the steamers steer their fleet by reversing, in order to clear a bend safely or avoid shoals or sand bars. It is this requirement which doubtless has developed the stern-wheel type of boat, which is found altogether on these rivers.

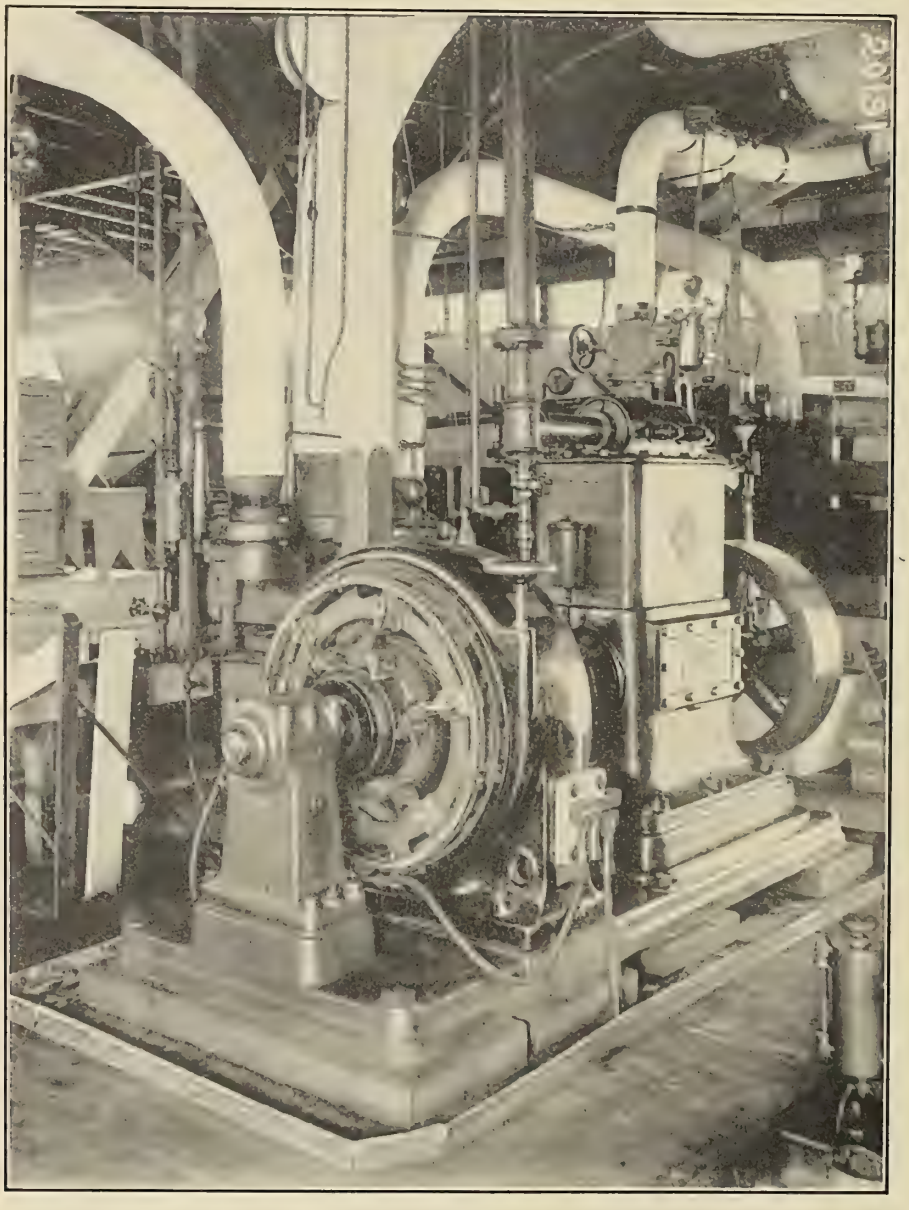
The engines are placed aft and are two in number, one on either side, each working through a long pitman or connecting rod to a crank at each end of the shaft. They are either compound condensing engines or high-pressure non-condensing, the latter being the usual type. Steam is supplied from long, cylindrical flue boilers placed forward. The horse power of the largest boats is about 2,500, while the smaller ones have proportionately less power.

The towboats of the largest class handle from 30 to 40 pieces or barges, containing a thousand tons each, below the falls at Louisville, while above this point the narrow channels and bends, and also the narrow bridge spans, will not permit of handling so large a fleet. The usual length of trip from Pittsburg to Louisville is

6 to 8 days and from Pittsburg to New Orleans about 30 days; the time, as above stated, depending upon the condition of the water and also the weather. The large river steamers burn from 1,500 to 2,200 bushels of coal every 24 hours when under way.

Of the towboats that ply between Pittsburg and Louisville, the *Ed. Roberts,* here illustrated, is a typical boat. She is 171 feet long, 32.5 feet beam, draws 5.5 feet of water. There are two high-pressure engines, the cylinders being 22 inches diameter by 7 feet stroke. Steam is supplied by 5 boilers, 40 inches diameter by 26 feet long. The *Roberts* was built at Madison, Ind., in 1884. Next to the new steamer *Sprague,* the *Joseph B. Williams* has handled the largest fleets on the river, the coal in a single fleet amounting to 50,000 tons. As this boat has already been described in Marine Engineering, her dimensions only will be given, viz.: length, 210 feet; beam, 40 feet; depth, 6.5 feet.

Another boat is the *Defender,* built in Pittsburg in 1881. She is 177 feet long by 41 feet beam by 7.3 feet deep; her tonnage is 514. The cylinders of the high-pressure engines are 24 inches diameter by 9 feet stroke; 6 boilers are installed, carrying steam at 181 pounds. This boat is in the New Orleans trade, and 11 other vessels, belonging to the same company, are similar in size and construction. Of the other steamers owned by the company, 24 are operated in the pools of the Monongahela, 25 run between Pittsburg and Brownsville, 12 are harbor boats for use at Cincinnati, Louisville, Cairo, and Dekoven, Ky. There are also tugs owned by the company operated at New Orleans.



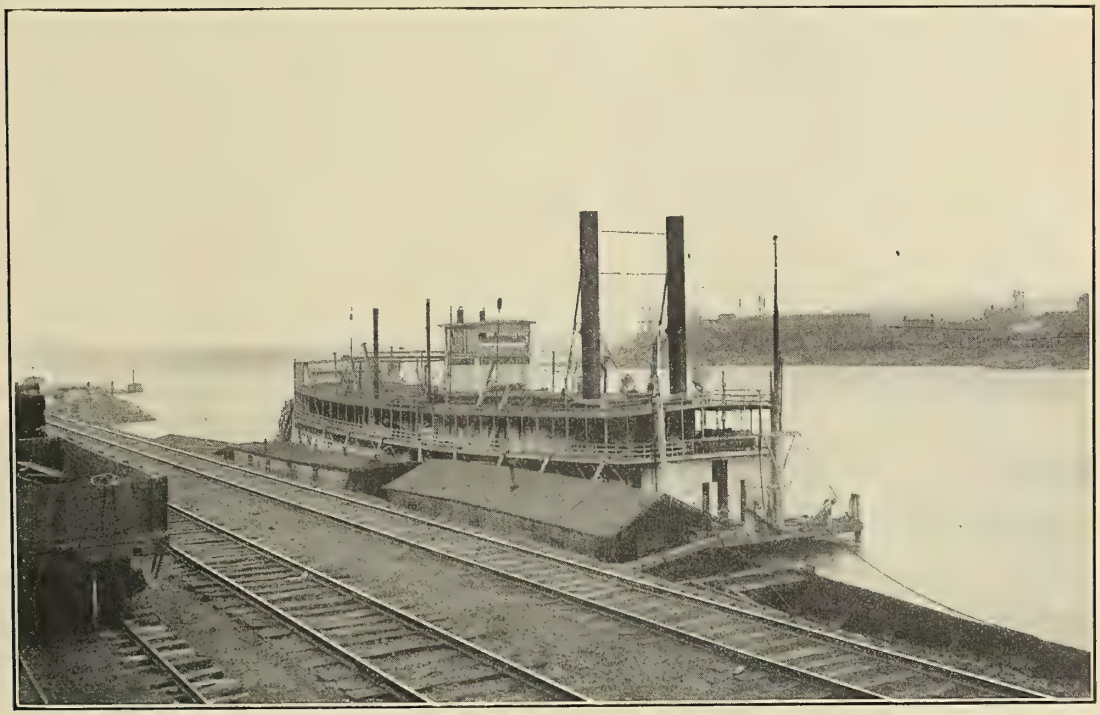
DECK VIEW ON OHIO RIVER STEAMER, SHOWING WESTINGHOUSE DIRECT-CONNECTED ELECTRIC-LIGHTING SET.

Of the pool boats, or jobbing boats, the *Harry P. Jones* is a fair example. Steamers of this class are only used for towing coal out of the pools or harbors to make up the fleets which are sent South. This boat

is 116 feet long, 22 feet beam, 4.5 deep, and draws about 3.5 feet of water. Her engines have cylinders 16 inches diameter and 4 1-2 feet stroke. There are but three boilers installed. This boat can handle 10 or 12 barges, containing 6,000 to 7,000 tons.

Nine of the vessels of this company are equipped with Westinghouse electric-lighting sets, from 15 to 30 kilowatts capacity each; some are direct-connected, while others are belted.

Cunard Liners.—While the authoritative announcement has not been made, it is generally understood that the Cunard Company has awarded contracts for the two new express steamers to Messrs. C. S. Swan and Hunter and to John Brown and Company, Ltd. As originally drawn the required maintained sea speed prevented builders from submitting bids.



OHIO RIVER STEAMER IRON AGE, USED IN TOWING THE COAL FLEETS ON THE OHIO.

ON SCREW SHAFTS.*

BY JOHN LIST, M. INST. C. E.

Increased size and power in merchant steamers has led to the more general adoption of twin screws, while at the same time there has been a distinct tendency toward comparatively full models, giving good carrying capacity on a moderate draft. This fulness of form has led naturally to the bossing out of the hull to house the stern tubes and shafts in place of fitting outside brackets, although the latter are retained in warships and other vessels of specially fine form. Where bossing out is adopted, the stern tubes and propeller shafts are usually similar in all respects to those fitted in a single-screw ship, and the shafts can be drawn inboard for examination without difficulty. Where, in very fine-lined ships, brackets are fitted with long, unprotected shafts outside the hull, it is necessary in many cases to draw the shafts outboard, which involves couplings removable from the shafts, thus introducing some mechanical difficulties, especially in the case of large and heavy shafts.

Where the usual form of stern tube is fitted, the shaft may be covered with gun metal throughout its length, which gets over, to a great extent, the risk of corrosion and consequent weakening of the shaft.

In recent years the changing conditions of trade (with the United States particularly) have led to cargo steamers being sent long voyages in ballast. In the case of single-screw ships in this condition, the propellers are usually only partially immersed, with the result that the consequent severe racing has led in many cases to broken shafts. So great has been the loss from this cause that the registry societies have found it necessary to modify their rules in the direction of increasing the size of the shafting.

The diagram (in the original paper only) shows a typical case of a defective shaft. This was made of ingot steel by a Sheffield firm, to Board of Trade tests. It was removed on survey, after having run about 743,000 miles. The point marked "B" at the forward end of the after liner had been lapped with marline to prevent grooving at the end of the gun metal, and that part had not wasted at all, whereas at "C," immediately in front of the lapping, the reduction in diameter was quite 9-16 inch, and the surface of the steel at that part was cracked all round, as shown in the developed view. The depth of the cracks appeared to be about 3-8 inch. In this case the stern bush was not worn down, nor was the shaft at all out of line. When disconnecting the shaft it was found to be strongly magnetic; that, however, is

*Paper read at the Engineering Conference of the Institution of Civil Engineers, Section V. *Shipbuilding*, June 18, 1903.

not uncommon in shafts which have been many years at work.

Where vessels are working in muddy or sandy waters the lignum-vitæ bearings of the stern tube are found to wear rapidly, and this has led to modifications where the bare steel or iron shaft runs on white metal, and is lubricated by oil which is fed into the stern tube by a pump driven by a cam on the tunnel shafting. To prevent access of sand or grit to the stern bush a metallic adjustable packing is fitted as shown in the diagram. The bronze spiral springs in this packing keep the rubbing faces in contact under a light pressure, and allow for the slight increase in length of the shafting due to the working temperature of the bearings and the heat of the tunnel. Steamers trading in the comparatively shallow waters of the Baltic ports are fitted much in the same way as that described.

Corrosion close to the face of the propeller boss, at the end of the gun-metal liner, used to be a fruitful source of failure of propeller shafts. This is now obviated by different forms of water stop. In these a ring of india rubber is squeezed against the surfaces so as to prevent access of sea water to the steel or iron. It is found that india rubber applied in this way and immersed in sea water will remain in good condition for several years.

The question of the life of steamship shafting is one of considerable importance, and it is no doubt desirable that shafts and other important working parts should be renewed, as in the case of locomotive crank shafts, after running a given mileage. Competition in ocean carrying is, however, severe, the conditions of trade are constantly changing, and ships become obsolete or unprofitable for the trade they were built for, and pass into other hands, so that renewals are not, as a rule, carried out unless defects incur rejection on survey by the Board of Trade or the registry societies. The practice, which is now becoming general, of building cargo steamers with one or more hold ballast tanks in addition to their double-bottom ballast capacity, will, by giving greater immersion to the propellers in the light condition, tend to reduce the risk of broken propeller shafts.

Shafts of moderate size are in some cases forged from selected scrap iron, but the amount of really good scrap in the market is small, and shafting for high-power ships is now generally forged from ingot steel. In first-class work about 40 per cent. of the top end of the ingot and about 5 per cent. of the total weight of the ingot from the bottom should be rejected in the forging. It is also, in some cases, specified that the sectional area of the finished forging is not to exceed one-sixth of the original sectional area of the ingot. It may safely be affirmed, however, that for the ordinary run of steel shafting for merchant steamers considerably smaller ingots, in proportion to the finished forgings, are used.

While for high-power cruisers propeller shafts of, say, 24 inches diameter are fitted, having the internal diameter about 75 per cent. of the external, it is not usual in full-power passenger ships to find such extreme proportions adopted. In the case of the Atlantic passenger ship *Deutschland* the particulars published give the external diameter of the propeller shafts as 25.2 inches, with an internal diameter of 10 inches. The conditions are, however, different. In the case of warships an excessive maximum power on the minimum weight is essential, and the question of first cost must be entirely subordinated to the attainment of that result, whilst at the same time the vessel generally steams at low power. Also the fineness of form necessitates very long outboard shafts with bearings far apart. In the case of the passenger ship the maximum seagoing power is continuously exerted and the shafts are carried in stern tubes housed in the bossing, and with long bearings spaced close together. For the hard and continuous work of the Atlantic high-speed service the arrangement adopted is that best suited to the requirements; but it is not applicable to a warship, where the extreme proportion of beam to length necessitates an entirely different form of model and arrangement of shafting.

Nickel-steel shafting has been largely adopted, not only in full-power ships on the Atlantic, but also in the shafting of many foreign warships. The crank shafts, thrust and propeller shafts of the *Deutschland*, before referred to, are of nickel steel, and in the later and still higher power ships of that class the same material is used. The ultimate tenacity of some heavy shafting forgings of nickel steel made on the Continent is 38 to 40 tons per square inch, with about 20 per cent. elongation, and a ratio of elastic to ultimate stress of about 67 per cent. Rather softer steel made in this country, and showing 3 to 4 per cent. of nickel on analysis, has been extensively used for shafting, so far with satisfactory results. Its ultimate tenacity is 36 to 38 tons per square inch, with about 30 per cent. elongation on 2 inches, and an elastic limit of 60 per cent. Such steel will bend cold. For warship-machinery forgings, carbon steel of high tensile strength has been used, having an ultimate tenacity of about 35 tons per square inch, with about 32 per cent. elongation on 2 inches, and an elastic limit of about 65 per cent.

DISCUSSION.

Mr. John Sampson said that Mr. List had raised the question of the amount of metal on the top and bottom of an ingot, which he had said was 40 per cent. and 5 per cent. respectively of the total. His company hoped soon to make ingots where 10 per cent. would be sufficient, as they were introducing a French process for compressing the steel during the casting of the ingot. With regard to tail shafts, it had often occurred to him that in view of the number of breakages, and the frequency of repairs, the cost of demurrage, loss of time, salvage, etc., it would pay the shipowner handsomely to increase the size of the shaft by as much as 40 per cent.

Mr. Harding said he thought the question of the racing of screw shafts might be more affected by reducing the weight of the propeller, which acted as a flywheel, than by increasing its diameter, and as a dividend earner the bronze propeller would pay very much better than heavy cast-iron or cast-steel screws. As to the annealing of tail shafts, he said that with mild steel it has been accepted as the correct practice to anneal after fire-working, but an exception was made of tail shafting. Mr. Harding thought the cracks in the shaft, which Mr. List specially referred to in his paper and illustrated by diagrams, were probably due to the

blow of the hammer in forging, not affecting the steel right into the heart of the ingot. He preferred lignum vitæ for bearings; it wore twenty or thirty times better when set with the end of the grain against the shaft than was the case in the old system of using it with the grain. In his experience amongst coral islands, lignum vitæ proved very much better than white metal. It involved fewer repairs. Nickel steel seemed to have great virtues when it was good; but he gave results to show that it was not always reliable, owing, he thought, to the fact that the nickel was apt to segregate at one or other end of the ingot; it was not always homogeneous. Moreover, the presence of nickel in the steel led to an increased corrosive effect of the steel in its vicinity. Nickel steel tubes in boilers would have a deleterious effect on mild steel plating.

Mr. R. T. Napier called attention to the great importance of making the tunnels strong, and of carrying the bearings well down to the structure of the ship, as this insured true aligning of the shaft. Many fractures were due to the shaft getting out of alignment.

Mr. William H. Ellis, of the Atlas Works, Sheffield, said that a head of 40 per cent. at the top of the ingot had been quoted as desirable, and this was put before steel makers as though it were going to keep them in order, but no policeman of this description would have that effect. Such a stipulation would not insure good steel, unless the manufacturer himself was determined that his work was to be sound from top to bottom; and there would be no difficulty in arriving at that result, even with ingots where only 25 per cent. was left to be cut off. Proper precautions must be taken in all cases apart from the head. It was not only a question of soundness that was concerned; soundness began before lack of uniformity left off, and this want of homogeneity was an important matter. Again, the question of relative area was always being forced on the steel maker; but this also could be overdone, and in his own recent work he had obtained far better results from Admiralty shafting, where the size of the ingot had been cut down well within the 6 to 1 limit, the reason being that the larger the ingot the greater the variation between the center and the outside; and it was this want of uniformity of structure that the steel maker had specially to guard against. He would like also to impress upon engineers the advisability of avoiding as far as possible the forging of shafts in such a way that half the shaft was forged in one direction and the other half in the opposite direction, after turning the shaft round. This caused a lack of homogeneity at the point where the forging in different directions met; in fact, it was almost necessary that a portion of the shaft, adjacent to the portion being forged, should be heated to the forging temperature and left without sufficient work being put upon it. As to iron shafts, the point to be kept in mind was the fact that in making them everything depended upon the forgeman. Many shafts had been brought to his notice which had had to be broken up for the reason that they had failed owing to the carelessness of the forgeman in not having obtained satisfactory welding heats. On the other hand, in the case of steel shafts it was necessary to insure a good quality of steel in the ingot, and an ingot properly produced to insure good homogeneity; and given that the forgeman obtained such an ingot, it was a comparatively simple matter for him to observe the necessary precaution to insure a satisfactory forging.

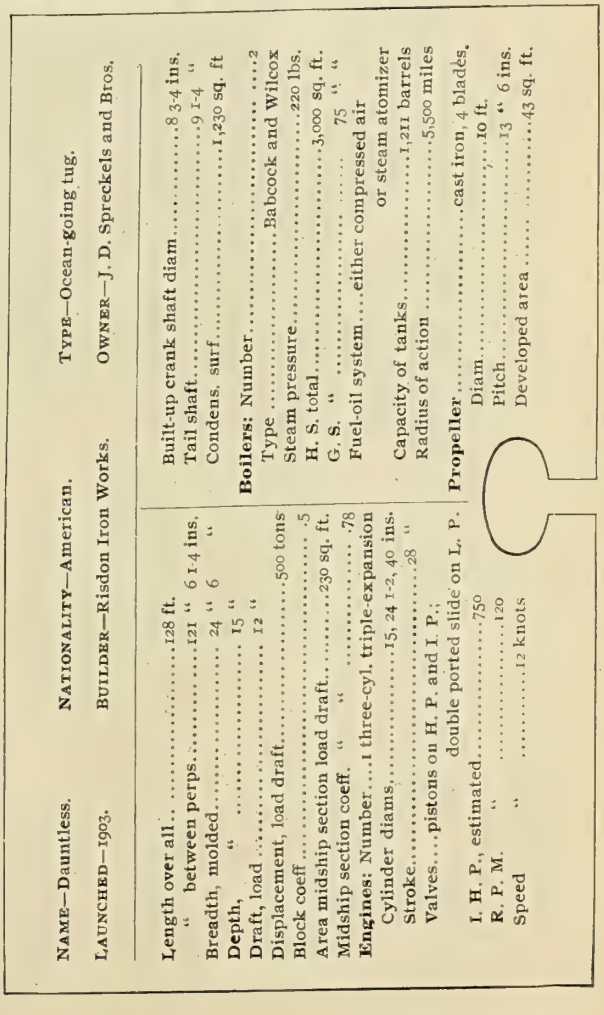
People were inclined to regard nickel steel as if it were ordinary steel; but, where introduced, it must have its own special treatment, because, if treated in the same way as ordinary steel, the results could not be satisfactory. He thought that treatment such as oil hardening and annealing was absolutely necessary for nickel steel. As to the question of test pieces, incidentally raised by Mr. Harding, he might state that on that very day the Standardization Committee were endeavoring to arrive at a standard in which the elongation would be relative to the area of the specimen. The question of elastic limit was not yet settled, and it was extremely difficult to register. Otherwise, they would probably see the ultimate strain discarded, and would use the elastic limit as the correct standard.

Mr. H. H. West said that Mr. List had referred to the bossing-out of the hull to house the shaft, but he thought that for high-speed steamers the old-fashioned A bracket affected speed less, although it did not afford such a rigid support for the larger shafts. Mr. West had had experience of a case where the boss was bored out in place during the construction, while the bossing was supported on shores which were very hard set. When these shores were removed the shaft was distinctly out of line, and he quoted a case where the extent was 7 1-4 inches. When the change in alignment was sudden, the evil was distinctly greater.

Name—Dauntless. **Nationality**—American. **Type**—Ocean-going tug.

Launched—1903. **Builder**—Risdon Iron Works. **Owner**—J. D. Spreckels and Bros.

Length over all	128 ft.	**Built-up crank shaft diam**	8 3-4 ins.
" between perps	121 " 6 1-4 ins.	**Tail shaft**	9 1-4 "
Breadth, molded	24 " 6 "	**Condens. surf**	1,230 sq. ft
Depth, "	15 "	**Boilers:** Number	2
Draft, load	12 "	Type	Babcock and Wilcox
Displacement, load draft	500 tons	Steam pressure	220 lbs.
Block coeff	.5	**H. S. total**	3,000 sq. ft.
Area midship section load draft	230 sq. ft.	**G. S.** "	75 " "
Midship section coeff. " "	.78	**Fuel-oil system**	either compressed air or steam atomizer
Engines: Number	1 three-cyl. triple-expansion	**Capacity of tanks**	1,211 barrels
Cylinder diams	15, 24 1-2, 40 ins.	**Radius of action**	5,500 miles
Stroke	28 "	**Propeller**	cast iron, 4 blades,
Valves	pistons on H. P. and I. P.; double ported slide on L. P.	Diam	10 ft.
		Pitch	13 " 6 ins.
I. H. P., estimated	750	Developed area	43 sq. ft.
R. P. M. "	120		
Speed "	12 knots		



OCEAN-GOING, OIL-BURNING TUG DAUNTLESS.

On the evening of May 5 there was launched from the shipyard of the Risdon Iron Works, San Francisco, the hull of a new oil-burning, ocean-going tug, *Dauntless,* which when completed will probably represent the highest type of development along these lines. This vessel is being built for J. D. Spreckels and Brothers Company, of San Francisco. It will comply with the highest class (100 A) of Lloyd's requirements, and in many respects is considered in excess of the rules, particularly with reference to cellular double bottom, bulkheads, and equipment.

Open-hearth steel is used throughout, including deck, deck-house erections, and companionways. The transverse bulkheads, extending the whole width of ship, of this house is an entrance to the crew's quarters, which are large and commodious and located under the main deck forward. On the starboard side of this entrance is a lavatory and toilet. Aft of this are located the mess room and galley, then come the boiler casings, and at after end of house is the upper engine room, in a corner of which is an additional toilet entered from the outside. Fourteen-inch air ports give this deck house ample light and air, and in addition to these there are gratings over the boilers and a skylight over the engines.

Immediately aft of the engine room, under the main deck, are the quarters of the engineers and mate, also a spare state room. Aft of the officers' quarters is the hawser locker. On the roof of the deck house

OIL-BURNING SEA TUG DAUNTLESS BEFORE LAUNCHING FROM THE RISDON IRON WORKS.

are five in number, and where necessary are fitted with water-tight doors. At the sides of the boiler space there are fitted two oil-tight longitudinal bulkheads. Oil is to be used for fuel in the boilers, the oil being carried in tanks which form part of the structure of the ship. There are eleven fuel tanks in all, one tank being in the double bottom forward of the boiler space, three tanks in double bottom under the boiler, three tanks on each side of same, and one tank in the space under the engines.

This minute subdivision has many advantages. Apart from being exceedingly beneficial in stiffening the hull structure, the ship is at all times under perfect control as regards trim, both longitudinally and transversely, and she is also rendered practically invulnerable against collision or grounding.

The comfort of the officers and crew has been well considered. The steel deck house is about 60 feet long by 12 feet wide by 7 feet high. At the forward end the pilot house and captain's quarters are located, this house being built of pine with an elliptical front, and erected on a steel coaming. Wood has been eliminated to a great extent in the construction of this vessel, and the sides and ceilings are in most cases cork painted instead of being sheathed. In the extreme ends of the ship are the peak tanks, fitted for carrying the supply of fresh water.

Great care has been exercised in the plating and riveting of the vessel, this being absolutely essential on account of the numerous subdivisions, and the severe testing that had to be gone through with while the ship was on the stocks, to prove the oil-tightness of the tanks.

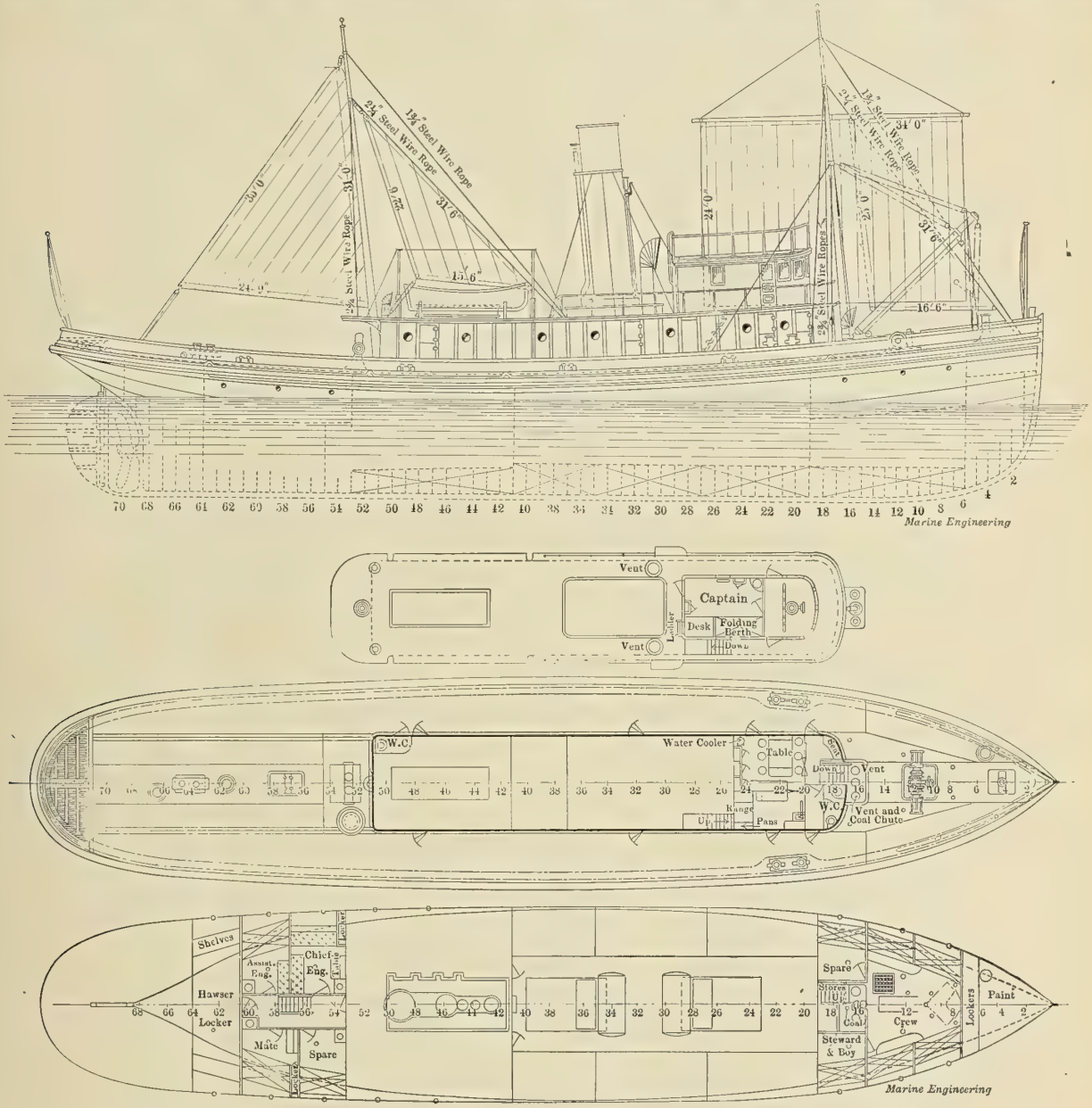
The vessel is fitted with two pole masts and has a complete set of sails, including a square sail on the foremast. A heavy derrick boom is also fitted to the foremast. Two 18-foot metallic lifeboats are included in the equipment, fitted with hinged, swinging davits.

The oil tanks have a capacity of 1,211 barrels, thus giving the boat a fuel supply for about 20 days' continuous steaming. This gives a radius of action of over 5,500 knots at an economical rate of speed, demonstrating the superiority of crude oil as a means of fuel for marine boilers.

The dimensions of the machinery will be found in the accompanying table. The main engine is of the

Steam is supplied by two Babcock and Wilcox water-tube boilers carrying steam pressure of 220 pounds per square inch. The boilers are placed in a fore-and-aft direction with one fire room between them; the uptakes lead into one funnel 5 feet in diameter.

The auxiliaries include two duplex vertical pumps, steam cylinder 6 inches, water cylinder 4 inches, and stroke 6 inches. The sanitary pump is duplex, 4 1-2,



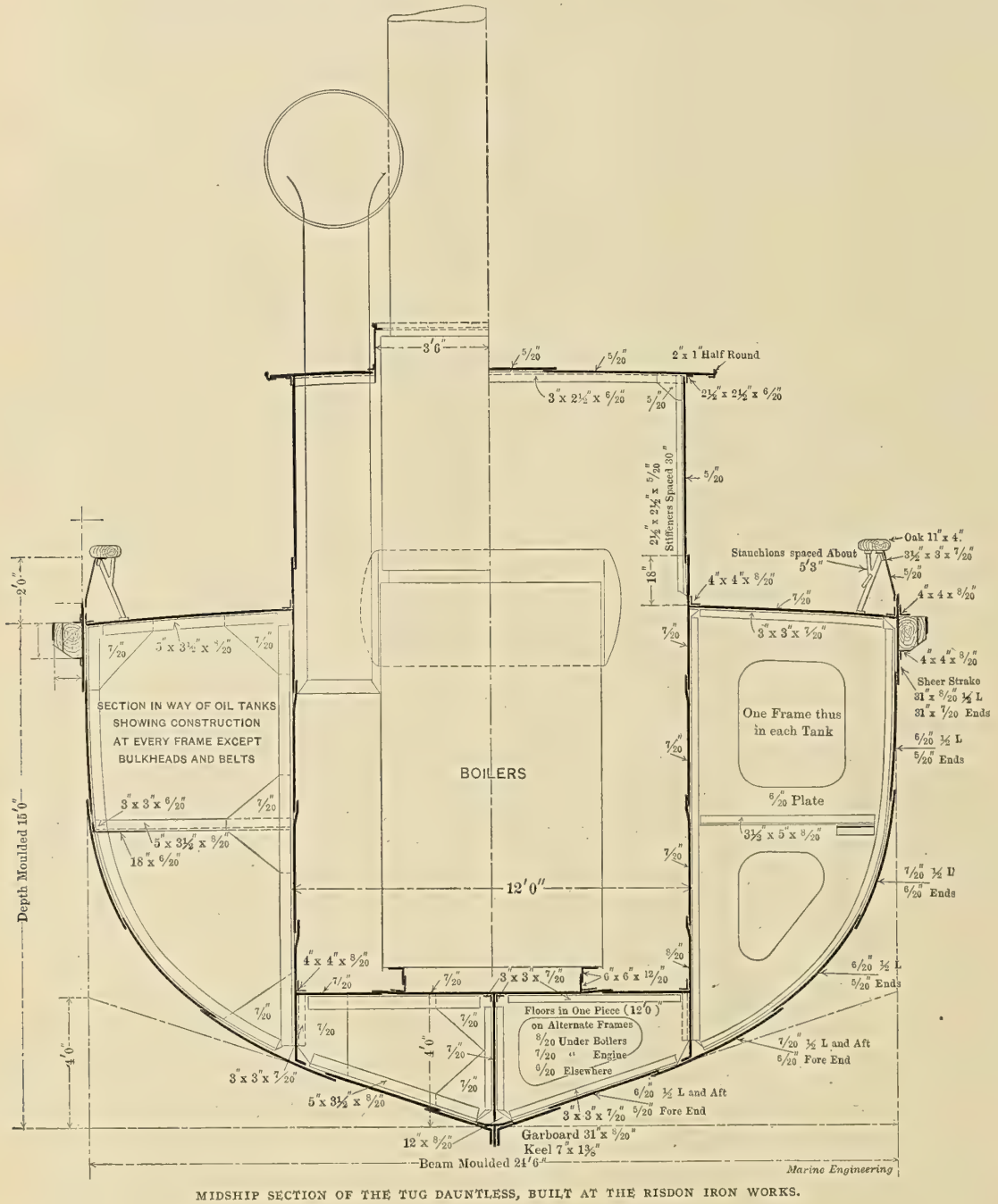
SAIL AND DECK PLANS OF THE OCEAN-GOING TUG DAUNTLESS.

usual inverted, triple-expansion type, built for working pressure of 220 pounds. The pistons are of cast iron, box section; the crossheads are of the locomotive type, and the piston rods 3 7-8 inches diameter; the connecting rods are tapering, from 4 1-2 inches at the lower ends to 3 3-4 inches at the upper ends. Reversing is accomplished by 7-inch steam cylinder with floating links. The crank shaft is built in three interchangeable sections and all shafting is solid.

3 3-4 by 4 inches; the bilge pump, 5 by 5 by 6 inches; the air pump is a twin-beam vertical compound with 5- and 10-inch steam cylinders, 14-inch air cylinder, all having common stroke of 10 inches; circulating water is supplied by a centrifugal pump. The donkey pump is duplex, 5 and 3 1-2 by 6 inches. The windlass is driven by a 6 by 8-inch engine and the steam capstan by a 5 by 7-inch double engine. Steam steering gear is fitted, the engine being 4 1-2 by 4 1-2. An electric light system is

installed throughout the vessel and consists of a 6 K. W. generator, driven by a standard De Laval 10 horse-power steam turbine, direct-connected. The guaranteed steam consumption of this outfit, with steam at 150 pounds and a vacuum of 24 inches, is 28 pounds of dry

used, of the vertical duplex piston type, 5 by 5 inches by 6 inches stroke. Either oil or steam can be used for atomizing, and all the piping is so arranged that a change from one to the other can be made almost immediately. For furnishing air a double crank and fly-



MIDSHIP SECTION OF THE TUG DAUNTLESS, BUILT AT THE RISDON IRON WORKS.

steam per brake horse power per hour at full load, and 33 pounds at one-half load.

The fuel-oil system is similar to that used on the other Spreckels ships and is manufactured by Tucker and Grundell. The piping is so arranged that oil can be admitted from any one tank to any other tank in the ship, and for this purpose an oil trimming pump will be

wheel compressor with an 8-inch steam cylinder and 12-inch air cylinder, both having stroke of 10 inches, is used. The oil pumps for delivering fuel to burners are two in number and of the same size as the sanitary pump, 4 1-2 by 3 3-4 inches by 4 inches. A Ross feed-water filter is used in connection with a pressure feed-water heater.

CAVITATION WITH SCREW SHIPS.*

BY J. A. NORMAND.

The attention of marine engineers has recently been directed to a phenomenon which may become manifest in the operation of a screw propeller, especially at extreme speeds. Its importance, for a long time unsuspected, appears to exceed that of all other causes of losses in efficiency. In fact, according as it is produced, even partially, or not produced, the power necessary to attain a given maximum speed may vary in the ratio of 3 to 2, or even 2 to 1. If it should be produced completely, no increase of power, no matter how great, would produce any increase of speed.

This phenomenon, to which some nine years ago at the close of a series of experiments with boat stationary I gave the name "rupture of cylinders of water acted on," is now known under the simpler name of "cavitation." Following are the characteristic features of this phenomenon:

The velocity of water in the induction pipe of a centrifugal pump cannot exceed a certain value, which depends primarily on the effective head. When this head is zero the maximum theoretical velocity is that of water entering a vacuum under atmospheric pressure, which is about 46 feet per second. This velocity is, however, never reached, on account of the inevitable losses of effect. Should the velocity of rotation become raised beyond that for which the pressure of the water at the pump admission is equal to that of the vacuum, the entering column of water becomes ruptured and the work is expended in eddies and whirls.

In the same manner in the case of a ship, the water rushes toward the propeller in virtue of the pressure of the atmosphere, augmented by that due to the height of the water line above the point of the propeller under consideration. The cylinder of water thus drawn toward the propeller remains entire and continuous so long as the velocity with which it moves does not exceed a certain value. Beyond such value cavities are formed and the power is expended in eddies and whirls.

There exist, however, two very important differences between the pump and the propeller. The inflow passage of the latter is not closed, and, furthermore, the acceleration which the propeller impresses on the water is not uniform for the various parts of the cylinder of water acted on. It follows that the average velocity of inflow for which rupture is liable to be produced is much further removed from the theoretical value than in the case of the pump. It may be remarked incidentally that the action is quite different in a ventilator or in an air propeller, on account of the expansion of the air.

The quantity of motion or momentum impressed on the water by the propeller measures the resistance of the ship. If the velocity, which forms one of the factors of this quantity of motion, is so high that cavitation is produced, the natural remedy will be to augment the other factor, the mass of the liquid, which in turn is proportional to the surface of the propeller.

These considerations have led me to the following simple rule:

The propulsive surface should be proportional to the product of the resistant surface by the speed, or, more exactly, to the quotient of the power by the square of the speed.

This gives the following equation, of which the first member represents approximately the propulsive surface:

$$nd^2r^{\frac{3}{4}} = J\frac{F}{V^2}.$$

n = number of propellers supposed to be identical.
d = diameter of the propellers in feet.
r = ratio of total developed surface of one propeller to that of the circumscribed circle.
F = maximum indicated horse power.
V = speed in knots.
J = numerical coefficient.

Experience shows that the coefficient J, which should be greater as the fineness of the form relatively to the speed is less, should never be less than 6.5, and may, with advantage, even exceed 8.5.

During the past three years and more this rule has received numerous verifications. It has provided the explanation of both exceptionally high and exceptionally low values of propulsive efficiency, which an examination of the form of the ship would not have accounted for.

For example, in a foreign navy three identical cruisers of 14,300 tons displacement and 31,000 I. H. P. were tried with propellers similar in their various characteristics except as to the pitch. They furnished maximum speeds sensibly the same. The curve of propulsive efficiency, however, plotted on speeds, showed a marked fall at the highest speed, and showed that an increase in speed of one knot would have required an increase of power of 15,000 or 20,000 I. H. P. On the last of these ships the original propellers were replaced by others with considerably greater propulsive surface. An increase in speed of more than a knot was obtained, without any sensible increase in power, and without the abnormal drop in the curve of propulsive efficiency. Evidently cavitation was produced with the original propellers. This indeed might have been foreseen by the aid of the preceding formula, inasmuch as the coefficient J showed a value of about 4.6, while with the later propellers its value rose to 6.5.

Thus a simple replacement of propellers, of which the cost represents scarcely one-third of one per cent. of the total value of the ship, sufficed to furnish a result which would have cost at the least thirty times as much had it been obtained by an increase in the power and in the dimensions of the ship.

It may be thought strange that a phenomenon of such importance as cavitation should have remained for so long unknown. The chief causes of this fact are the following:

(1) For many years past speeds have been steadily on the increase, but notwithstanding this fact it has been too often assumed that the values of the proportion between the propulsive surface and the resisting surface of the ship which were formerly in use, and quite sufficient under early conditions, might still be employed; while in fact this ratio must vary with the maximum speed. In consequence of this the velocity of flow of water to the propeller has greatly increased in fast

*Translated from *Comptes-rendus*, séance du 27 Octobre, 1902.

ships, and it is almost invariably with such that cavitation has been observed.

(2) Several eminent engineers, basing their deductions upon considerations which were quite exact in appearance, but which neglected the possibility of cavitation, then unknown, have assumed that the values of the slip commonly employed might be safely increased. Thus William Froude, to whom are due most valuable researches on waves and who justly enjoyed a high authority, said in 1878:

"Far from considering a large value of the slip as causing a loss of power, the opposite may be the case." He added: "A propulsive surface quite reduced in amount may be admitted without great loss of efficiency."

At that time the maximum speed of cruisers was about 18 knots. At the present time it is 24 knots and upward.

(3) It was at about this time that the first model-testing tanks were established. At the present time it is the rule in many navies to proceed with the execution of the design of a warship only after the model trials, which are made with the addition of propellers in order to approach as closely as possible to the conditions of service. It has been assumed that the laws of comparison were almost rigorously applicable, on condition that the speeds were proportional to the square roots of similar linear dimensions in the two cases. Such is indeed the case, except in so far as cavitation may enter, unless, indeed, the pressure of the atmosphere should be reduced in the proportion of the linear dimensions of the model and ship. The velocity of the water flowing to the propeller is produced, in fact, in virtue of the external pressure, increased by that due to the height of the water surface above the propellers. This last height is indeed proportional to the linear dimensions of the model, and would impress, if it acted alone, a velocity proportional to its square root; that is to say, to the corresponding speed of the model. But for the model experiment the pressure of the atmosphere is by far the more important element, and this remains constant in all such experiments. Model experiments with propellers, as they are now carried out, cannot, therefore, give direct evidence regarding the phenomenon of cavitation. It is therefore not permissible to attempt to deduce from such model experiments the results for the ship herself as regards this phenomenon. It must not, however, be concluded that such experiments are without value. On the contrary, they may furnish valuable indications, so long as they are not made of direct use in the determination of the dimensions of the propellers. For the latter, special rules should be employed.

VIEW ON THE BAY OF FUNDY AT LOW TIDE.

Many formulæ, based on experience, have been proposed for the calculation *a priori* of the speed of ships. If the propulsive surface of certain of these ships whose trials may have served to establish the formulæ was so small that cavitation may have been produced, it is probable that these formulæ are inexact at the extreme speeds.

Rear-Admiral Melville to Retire.—The Secretary of the Navy has appointed Captain Charles W. Rea to be Engineer-in-Chief of the Navy, to take the place of Rear-Admiral George W. Melville, who is soon to retire on account of the age limit. General satisfaction is felt throughout the Navy on the particular suitableness of this appointment.

LARGE EBB AND FLOW IN HARBOR.

BY GEORGE H. WARING.

The harbor of St. John, N. B., Canada, being an inlet on the shore of the Bay of Fundy, causes it to partake of the large ebb and flow of tide for which that bay is noted. The maximum ebb and flow of the bay is 60 feet, and takes place at its head, and this harbor, being near its mouth, has an ebb and flow maximum of 28 to 30 feet and a minimum of 15 to 18 feet. The maximum flow occurs twice each month, coming gradually each tide from the minimum until the highest is reached, and then each ensuing tide is less until the minimum is again reached, the highest and lowest tides occurring when high water comes at midday or midnight, and the very fullest when the full moon comes at that time.

REVERSIBLE FALLS BETWEEN RIVER AND HARBOR AT ST. JOHN, N. B., THE TIDE FALLING.

It would be expected by those not acquainted with such large rise and fall of tide that there would be great difficulties to navigation presented, but experience has shown that is not so, and the handling and care of vessels in this harbor is not greater than in most of our North American harbors, and, in many cases and for some uses, the rise and fall is an advantage. While this rise and fall is so great, the main channel of the harbor has ample depth of water at the lowest ebb to float the largest steamers built; and for docking and loading them, what Nature has not done the city has—that is, constructed wharves or docks at which steamers can lie at all times afloat.

The smaller steamers and sailing vessels up to 200 tons generally are docked in slips which are entirely clear of water on the ebb tide. This has been found to be a perfectly satisfactory method of using that class of vessel, and it is no uncommon sight to see 30 or more of them lying comfortably on the ground. As almost all these vessels have considerable dead rise, the usual custom in mooring is to give them a slight list before they touch bottom on grounding, which careens them against the wharf at which they are lying. It is a very rare occurrence to have an accident or upset; in fact, it would be only carelessness or neglect that could cause it.

Advantage is taken of this high water for docking all classes of vessels and for repairs. At several places in the harbor timber gridirons are laid down on which vessels are floated to be left dry at ebb tide, during which time general repairs and painting or coppering are carried on, thus making a very cheap dry-dock. This method has been carried on for years; the men engaged at the work thoroughly understand the tides and do very satisfactory work. It is no uncommon sight to see one of our ocean steamers high and dry in one of the slips, having blades put on the propeller or other outside repairs or painting under way.

Advantage is also taken of the tide by ocean liners carrying cattle or horses, for, by catching the tide right, the animals may be driven on board, on spar or hurricane deck, across a level gangplank, a full cargo of cattle or horses being loaded in two hours.

A strange sight to many who visit this port is the tide running into St. John harbor from the Bay of Fundy, and, at the same time, the water in the harbor ebbing rapidly; in fact, the flow of water is inward until the tide has ebbed about seven feet. The reason for

this remarkable condition, which is believed to exist in no other part of the world, is accounted for by the restricted outlet of the river which enters the upper end of the harbor.

The mouth of the river is through a narrow passage between two cliffs, as shown in the illustration on page 413. While the great ebb and flow occurring in the harbor amounts to 27 feet, the river is virtually non-tidal, its ebb and flow being only about 18 inches, as the waters of the bay are held back by the barrier above mentioned. The normal level of the river is about 7 feet below high level in the harbor; thus, on the flood tide, the water flows into the harbor, and when it has reached the level of the river, viz., 20 feet above low water, it flows through the barrier. The rush of water through the barrier increases steadily up to high water, when there is a head of 7 feet between the two levels. When ebb tide starts it will be seen that the water is flowing out of the harbor in both directions, viz., into the river and into the bay, the former gradually slacking off until the levels in the river and the harbor are the same; and, as the tide continues to ebb, the water in the river then flows into the harbor, the flow increasing steadily, so that by low water there is a head of no less than 20 feet in the falls at the mouth of the river. Thus there are reversible falls through this junction, and navigation, which is very large, has to be done when the level period occurs, which is four times every twenty-four hours, and lasts about twenty minutes each time.

MARKET SLIP AT ST. JOHN, N. B., SHOWING IMMENSE FALL OF TIDE.

Fiscal Year's Shipbuilding in the United States, July 2, 1903.

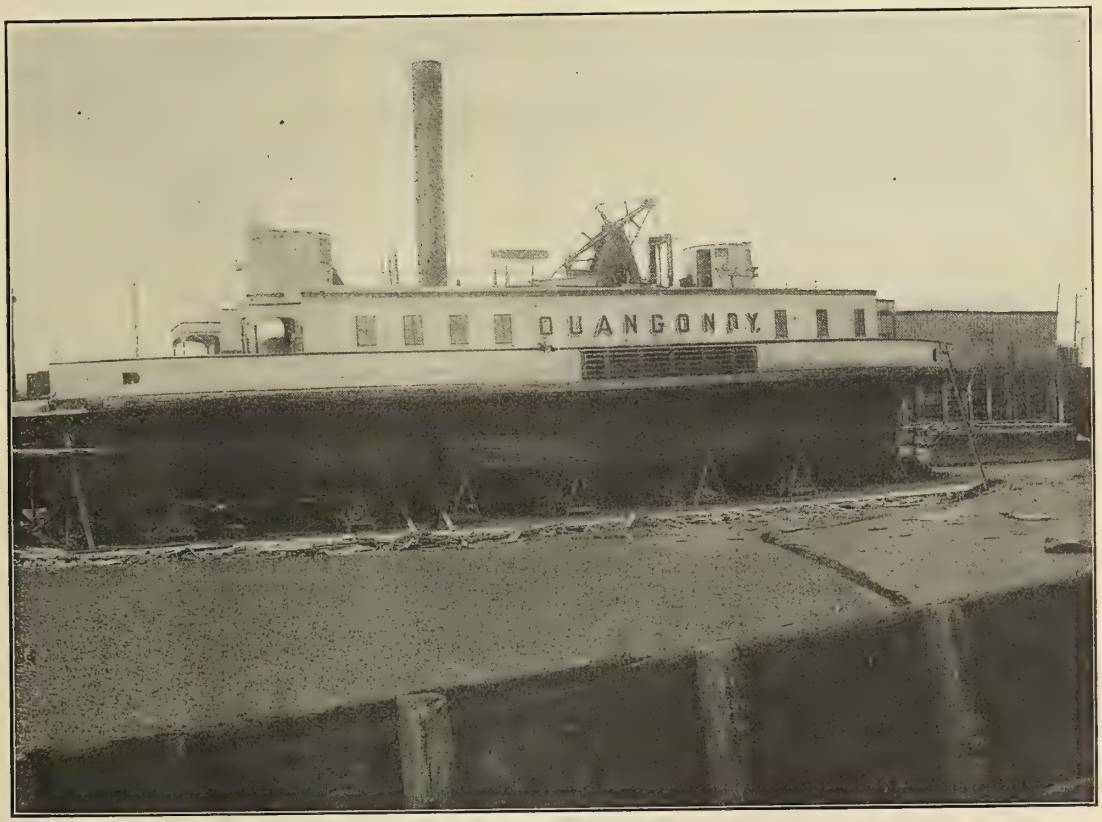
During the fiscal year ended June 30, 1903, the Bureau of Navigation states that 1,535 vessels, of 455,076 gross tons, were built in the United States and officially numbered, compared with 1,657 vessels, of 473,981 gross tons, for the previous fiscal year. Returns of vessels under construction on July 1, 1903, in the United States, indicate for the new fiscal year an output below that of the year just ended.

The world's shipbuilding reached its highest point in 1901. The diminished output since then has been less noticeable in the United States than abroad. Thus, Lloyd's latest returns show that on March 31, 1903, in the United Kingdom, 425 vessels of 974,685 tons were under construction, compared with 431 vessels of 1,240,344 tons for the same day in 1902.

The principal decrease in the United States for the past year has been in steel steamers built on the Great Lakes, which numbered 41 of 131,660 tons, compared with 52 of 161,797 tons for the fiscal year 1901-2. The only item of considerable increase has been the cheaper forms of construction—unrigged canal boats, barges, etc. —numbering 320 of 79,574 tons, compared with 297 of 57,502 tons for the previous year. Nearly two-thirds of the year's output consists of 92 vessels of over 1,000 tons each, aggregating 295,548 gross tons. Of these the Great Lakes' yards built 37 steel steamers, aggregating 130,283 gross tons, four of which, aggregating 7,147 tons, are built to pass through the Welland Canal for ocean coasting service. Three Lake steamers, *James*

H. Reed, D. G. Kerr, and *D. M. Clemson,* each slightly exceeds 5,500 tons.

On the seaboard 18 ocean steel steamers, of 101,471 gross tons, were built, the largest output of this type in our history. The large vessels of this type contracted for in 1900 are now completed or will be completed, barring strikes or unforeseen delays, in the early spring and summer. No new contracts for this type have been made in two years. The year's additions were the *Finland,* of 12,760 tons—the largest vessel built in the United States this year—and the *Mississippi, Maine,* and *Massachusetts,* each of 7,913 tons, all four for the International Mercantile Marine Company; the *Siberia,* 11,284 tons, for the Hawaiian-Asiatic trade of the Pacific



METHOD OF DRY-DOCKING ON THE BAY OF FUNDY. THE VESSEL IS FLOATED ON THE GRID AT HIGH TIDE AND AS THE TIDE RECEDES IS LEFT HIGH AND DRY.

Mail, and the *Arizonian* and *Texan,* over 8,600 tons each, for the American-Hawaiian Company. Other steamers are for the coasting trade, of which 4 steamers, of 12,974 tons, carrying oil in bulk, are noteworthy.

Two barkentines for Pacific trade, aggregating 2,638 tons, were the additions to the square-rigged fleet. The new wooden schooners over 1,000 tons numbered 21, aggregating 36,537 tons. The steel schooner *Thomas W. Lawson,* of 5,218 tons, was documented early in the year. Other new vessels over 1,000 tons are 3 wooden steamers, aggregating 4,605 tons; 3 ferry and river steel steamboats, aggregating 3,849 tons; and 7 rigged barges of 10,947 tons.

United States Supervising Inspectors.—The Board of Supervising Inspectors of Steam Vessels has completed its session revising the Rules and Regulations, and will submit its recommendations to Secretary Cortelyou.

EXPERIMENTS ON THE RESISTANCE OF A SCREW STEAMER IN FREE ROUTE.—I.*

BY H. ENNO VAN GELDER.

In a recent paper, on the resistance of ships in free route, read before the Ninth International Congress in Düsseldorf, Professor Oswald Flamm called special attention to the importance of the accurate determination of this resistance, whether through experiments on models or on full-sized ships. Experiments of the latter character are of the greater interest and value because the proper relation between the resistance of the model and that of the ship is not yet definitely known, and because further all such direct experiments which may be able to provide data on this subject are of the highest importance.

When an experiment is carried out on a model in which the latter is towed at a certain speed through the water, the resistance opposed to the motion is indeed measured, but this is not the resistance which would be met with were the model, like the ship, moved by its own propeller. This arises not alone because the propeller blades experience resistance in their movement through the water, but also because the propeller itself sets up a movement in the water in the immediate vicinity of the stern of the ship and thus produces an additional resistance to the forward movement of the ship.

These additional resistances can hardly be measured by model experiment, and are only to be satisfactorily

*Translated specially for Marine Engineering from *Schiffbau,* December 23, 1902, and January 8, 1903.

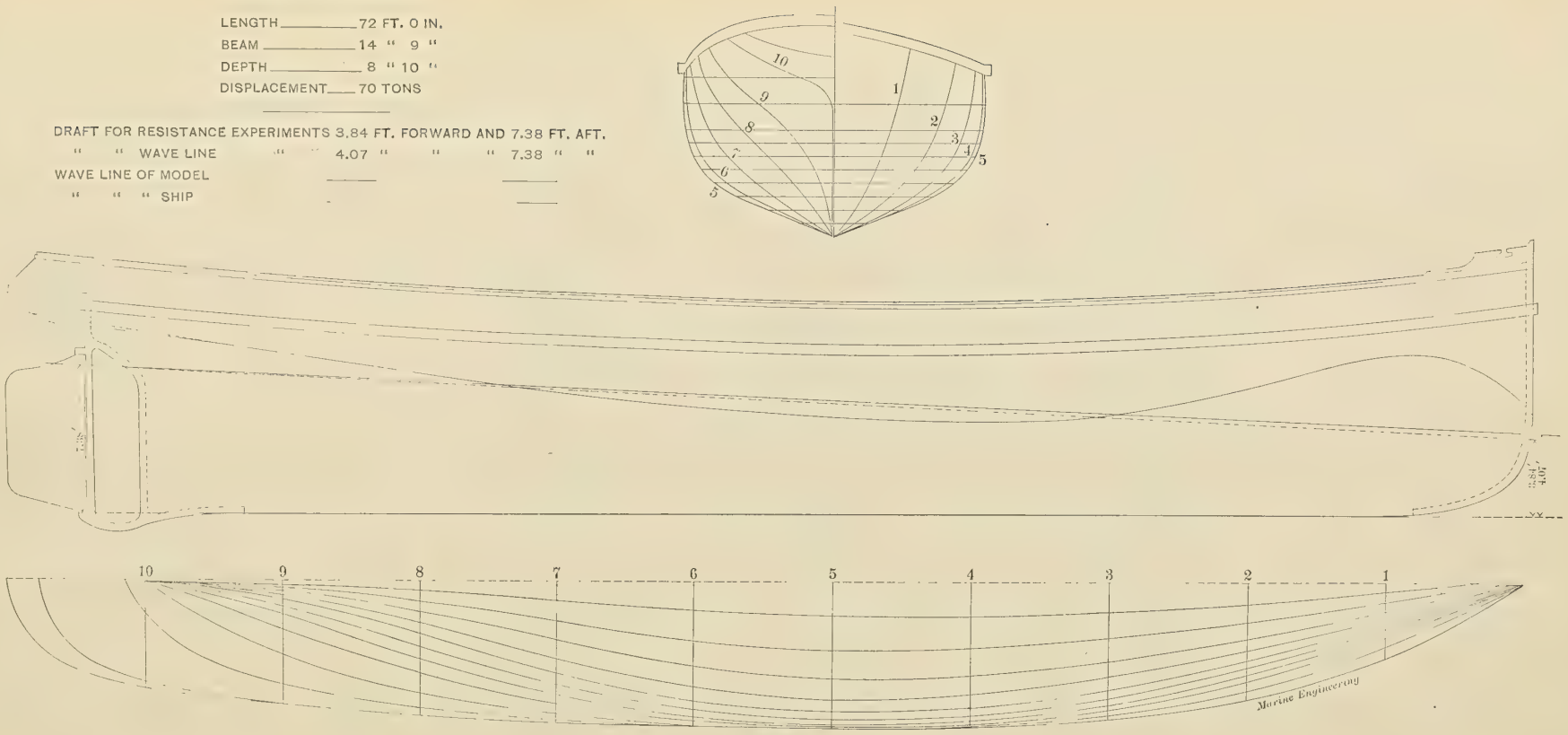


FIG. I.

investigated through experiments on the ship itself. In the matter of model experiments the procedure is still substantially as follows:

The frictional resistance of the model is computed by empirical formula, and this is subtracted from the total measured resistance of the model. The remaining resistance is then transformed by the law of comparison into the resistance of the ship at a corresponding speed, assuming that the resistances of similar forms at corresponding speeds are in the ratio of the displacements.

Next, in a similar manner as for the model, the frictional resistance of the ship is computed by empirical formula, and this is added to that derived by the law of comparison, and the sum is taken as the total resistance of the ship at the given speed.

"Herein," notes Professor Flamm, "lies most certainly a definite uncertainty in the determination. The question properly arises whether, based on the observations of Froude regarding skin resistance, it is admissible to divide the automatically recorded total resistance of the model into these two parts, skin resistance and form resistance; further, whether it is admissible to add the skin resistance of the ship determined by formula to the form resistance determined by the law of comparison from the model. At the most it can be said that experience indicates that practically the total resistance of the ship is equivalent to that derived by model experiment at corresponding speed. This conclusion is, however, to a considerable extent based on a further empirical and unproven hypothesis. In order to make this clear it is necessary to show in further detail the method of computation. Suppose the case in which, through a model experiment, it has become possible to

determine the resistance of a ship at a given speed, having reference as well to the operation of the screw propeller. Even so this will only furnish the *net* ship resistance. If this resistance be multiplied by the speed to which it corresponds there is thus obtained the net propeller power; that is, the work which must be developed at the surface of the propeller in order to force the ship through the water with the speed in question. This, however, is not the total work which must be developed by the engine, and even at the present time we are unable with assurance to relate the one to the other.

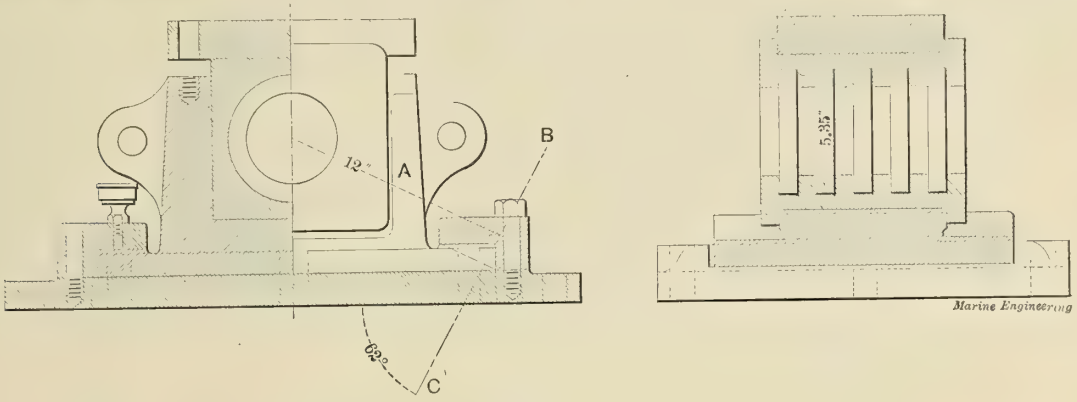


FIG. 2.

In earlier times, indeed, and especially in the first years of the steamship, many attempts were made, particularly in France and England, to accurately determine the mechanical efficiency of the marine engine, but without results of practical value. In consequence it became and yet remains customary to measure and to deal with

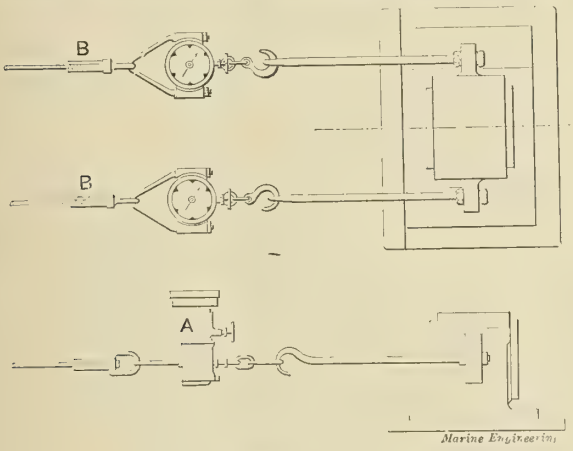


FIG. 3.

the indicated power of the engine; that is, with the total power developed in the cylinders. How much of this power is finally effectual and how much becomes lost on the way from the cylinders to the surface of the propeller, we have as yet no accurate means of determining."

It is therefore of the greatest importance to be able to accurately determine this loss of power in the transmission, and, to this end, two items may be sought, namely, the thrust power—that is, the actual power developed by the push at the thrust bearing—and the mechanical efficiency of the engine. The latter must be determined from the engine itself, or may, from the analogy with other available types, be assumed for the marine engine with reasonable accuracy. The thrust on the thrust block must in any case be measured on the ship, and to this end it is necessary that the thrust block be made movable—as, for example, by placing it on slides—so that the load which it carries may be measured by some appropriate form of dynamometer.

Such experiments are of the greatest value, and all marine constructors will learn gladly of the researches recently carried out by Herr Murk Lels, Director of the Kinderdyk shops near Rotterdam, relating to the resistance of a small screw steamer.

This steamer was the *Vlaardingen,* of which the lines are shown in Fig. 1, and of which the chief dimensions are as follows:

Length	72 feet
Beam	14 " 9 inches
Depth	8 " 10 "
Displacement	70 tons
Diameter H. P. cylinder	12 1-2 inches
" L. P. "	25 "
Stroke	18 "
Boiler pressure	100 pounds per square inch
Diameter of propeller	6 feet 3 inches
Pitch of propeller	7 " 7 1-2 "
Developed surface of propeller	15 square feet.

The purpose of these experiments was to measure the reaction of the pressure of the propeller on the water, and thus the actual resistance of the ship with reference to the work of the engine, all at a series of different speeds. To this end the direct load on the thrust block was measured, and this load multiplied by the corresponding speed gives the net power required to push the ship through the water at this speed. This is then compared with the work developed by the engine during the corresponding part of the trial.

To this end the thrust block (see Fig. 2) was made movable on a cast-iron sole plate, and was connected with two dynamometers for registering the load. The entire installation was somewhat similar to crosshead and guide, and the block was prevented from turning with the shaft by two gib pieces fitted as shown. The surfaces of the block, sole plate, and guides

were very carefully made and were provided with oil grooves and means for lubrication in such manner as to reduce friction to the lowest amount. Computation showed also that the load on the ways was very small, amounting to only some 2 pounds per square inch. On both ends of the sole plate stops were cast, the distance between which was .32 inch greater than the length of the base of the thrust block. This clearance provided sufficient play for the proper control of the block by the dynamometers. In order that the shafting might be free to take up such movement, a longitudinal clearance of .36 inch was left at the main pillow blocks, and a like clearance between crank pins and connecting rods.

The dynamometers were two in number and of the Duckham type, consisting of a hydrostatic scale which measured the pressure by manometer, the general arrangement being shown in Fig. 3. These dynamometers were secured to each side of the block by means of lugs, as shown, and on the other side to a convenient part of the ship. To avoid the danger of an incorrect indication through the weight of the dynamometers, the latter were suitably hung from the deck beams. The observer whose duty it was to watch the dynamometers and record the load had also to watch the position of the thrust block, and, by the adjustment of suitable screws connected with the dynamometers, keep the block freely floating between its stops and thus under the control of the weighing apparatus.

In the preliminary tests it became plainly apparent that it would be almost impossible to read the load on the dynamometers, on account of the great variation, even during a single revolution. This variation was so extreme and rapid during each revolution that it was found quite impracticable to make any satisfactory observations of the load by this means. The inertia of the moving parts of the dynamometers and manometers was so great that one might at times as readily read 500 as 5,000 pounds. This irregularity was, however, completely overcome by the insertion of a small throttle valve (*A*, Fig. 3) between dynamometer and manometer, by means of which the movement of the liquid to and fro could be controlled exactly as desired.

During the run of one sea mile the pressure was read five times. The horse power was computed from diagrams taken at the same time, while the revolutions were counted by two observers and checked by tachometer. The course on which the trials were carried out was determined by ranges covering an official sea mile measured off on the island of Rosenburg, and the time for each run was taken by two observers.

On the whole, seven trials were made on this course, and at varying values of the speed, each trial comprising one run with and one against the tide, the two in immediate succession. The data resulting from these trials will be found in collected form in the accompanying Table I. In this table, in column 12 will be found the thrust power entered; that is, the power given by the multiplication of the thrust on the block, in pounds, by the speed per second, in feet, and the division of the product by 550. Column 13 gives the fraction of the total developed power utilized as work of propulsion.

TABLE I.

Number of Run.	I. H. P.		Revolutions.		Load on Thrust Block in Pounds.		Speed of Ship, Knots.	Speed of Propeller Knots.	Slip of Propeller.		Thrust Power.	Col. 12 / Col. 3
	Separate.	Mean.	Separate.	Mean.	Separate.	Mean.			Knots.	Per cent.		
1 up	33.25	31.03	96	94	1,895	1,907	6.97	7.08	.11	1.55	19.76	63.68
1 down	28.80		92		1,917							
2 up	48.06	50.56	110	111	2,827	2,762	8.07	8.36	.29	3.47	33.16	65.58
2 down	53.06		112		2,696							
3 up	81.40	80.24	128	127.5	4,081	3,966	9.02	9.60	.58	6.04	53.22	66.32
3 down	79.09		127		3 851							
4 up	132.82	132.35	148	148	5,950	5,968	10.07	11.14	1.07	9.60	89.43	67.57
4 down	131.89		148		5.988							
5 up	167.05	170.83	160	160.5	7.524	7,630	10.47	12.09	1.62	13.40	118.85	69.57
5 down	174.61		161		7.735							
6 up	234.13	230.58	175	175	10,244	10,007	10.84	13.12	2.28	17.37	161.40	70.00
6 down	227.04		175		9,771							
7 up	255.12	260.32	180	180.5	10,567	11,007	11 01	13.60	2.59	19.04	180.29	69.25
7 down	265.52		181		11.047							
1	2	3	4	5	6	7	8	9	10	11	12	13

Although the work was carried out with the greatest care, yet the results for efficiency showed certain values excessively high. These results must have been caused either by too high reading for the dynamometers or too low values for the indicator cards. It appears most likely that the latter was the case, as the dynamometers and manometers were very carefully standardized by direct loading with weights, and indications of slight error in column 6 thereby corrected. It would therefore appear that the developed power may have been greater than as indicated by the diagrams. This may have been in large part due to the fact that but one indicator was used on each cylinder. Through the influence of throttling and cooling, the effect in the indicator may have fallen below that in the cylinder. It would have been much better to employ two indicators, one for each end of the cylinder, and connected as directly as possible in order to reduce to a minimum all losses of this character. Nevertheless these results still have their value as a basis for comparison, since it may be confidently assumed, with engines of about the same size, that at least the relation between the power actually developed in the cylinders and that shown on the diagrams remains sensibly constant.

(To be continued.)

STEAMER CALVIN AUSTIN, FOR THE BOSTON AND PORTLAND LINE.

NEW STEAMER CALVIN AUSTIN, FOR THE EASTERN STEAMSHIP COMPANY.

There has just been built by the Harlan and Hollingsworth Company, Wilmington, Del., a fine new steamer for the Boston-Portland service of the Eastern Steamship Company. The new vessel is named the *Calvin Austin,* and is in many respects a duplicate of the steamer *Gov. Dingley,* now running on that line. She is what might be termed an intermediate type between the coasting steamer and the steamboat. Her over-all length is 320 feet, beam at the water line 48 feet 3 inches, and beam over guards 62 feet. The other dimensions are to be found on the data card at the end of this article.

INTERIOR ARRANGEMENT.

The interior of the ship has been laid out with an eye for the comfort of the passengers. The quarter deck or main entrance is on the main deck; aft of the engine space, on the starboard side, is the purser's office, and aft of this is a pantry. Glass doors open into the main dining saloon. Continuing aft is the ladies' cabin. Opening off the quarter deck are the coat and wash rooms, while on the port side is the crew's mess. The grand staircase leads to the hurricane deck above and to the lower deck. As shown in the joiner plan of lower deck, there are cabins forward and aft for men and women, along the sides of which are arranged six-berth rooms; each passenger is allotted a berth with a transportation ticket, as is the custom on Long Island sound and other lines. On the port side, abreast of the engine room, is the kitchen with adjoining pantries, while in the after cabin a table for the officers' mess is spread.

The main deck amidships and forward is given up to freight space, freight being loaded through large side ports, the doors of which are suspended on roller tracks. In the forecastle are the quarters for the firemen, sailors, etc., and the ship windlass.

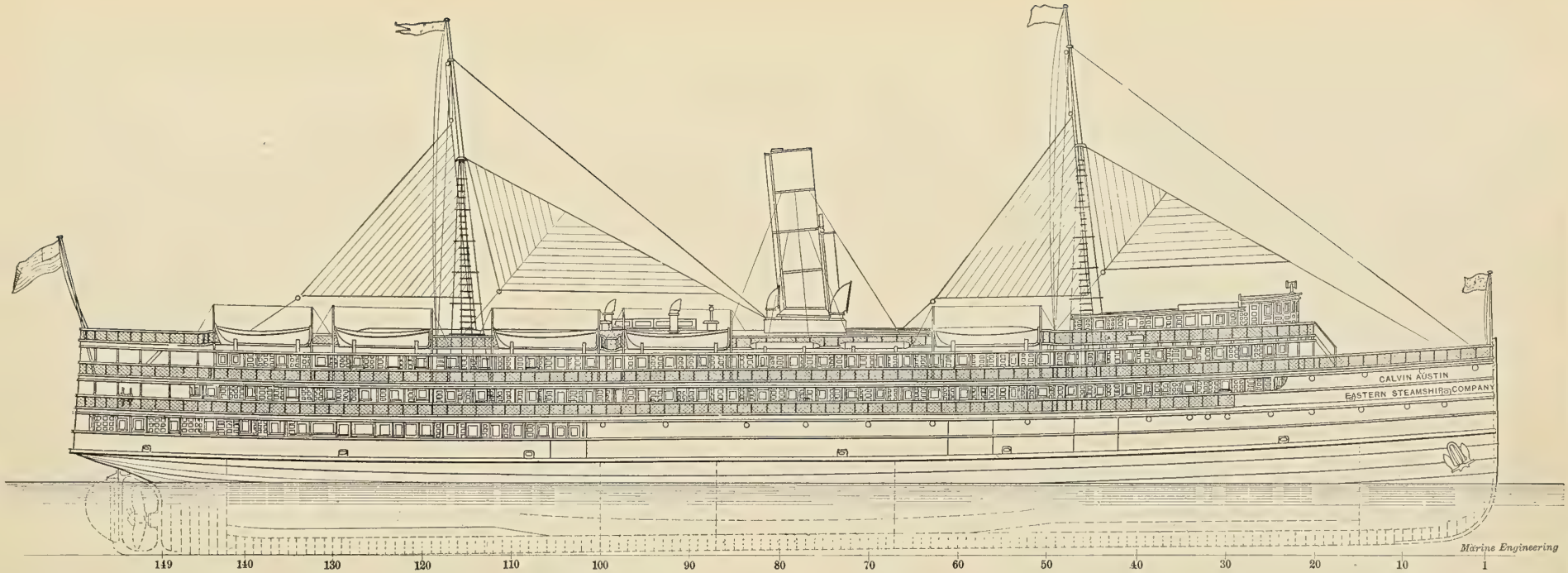
Ascending the main stairway on the quarter deck one arrives at the main cabin on hurricane deck; double tiers of inside and outside state rooms run almost the entire length of the cabin. At the after end of each side are three large rooms with beds, amidships are the toilets, while forward there are bed rooms, linen locker, etc. The outside rooms are entered from the open deck, which runs to within about 45 feet of the stem. Forward of this bulkhead is the crew's space. This deck is not shown in the accompanying plans, as it is practically a duplicate of the gallery deck. Two large wells, one aft of the engine-room casing and one forward of the boiler casing, bring abundant light from large skylights above, to the main cabin on the hurricane deck. Handsome staircases are placed one forward and one aft. Above the gallery deck are the pilot house and officers' quarters.

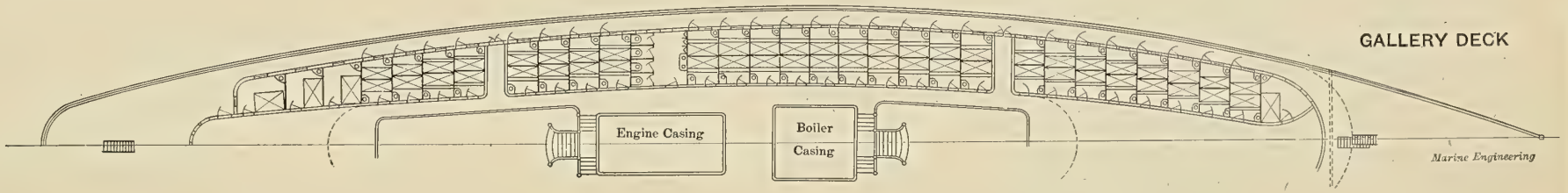
The equipment of anchor, lifeboats, etc., is according to the United States rules. The ship is fitted with two pole masts and one funnel.

HULL.

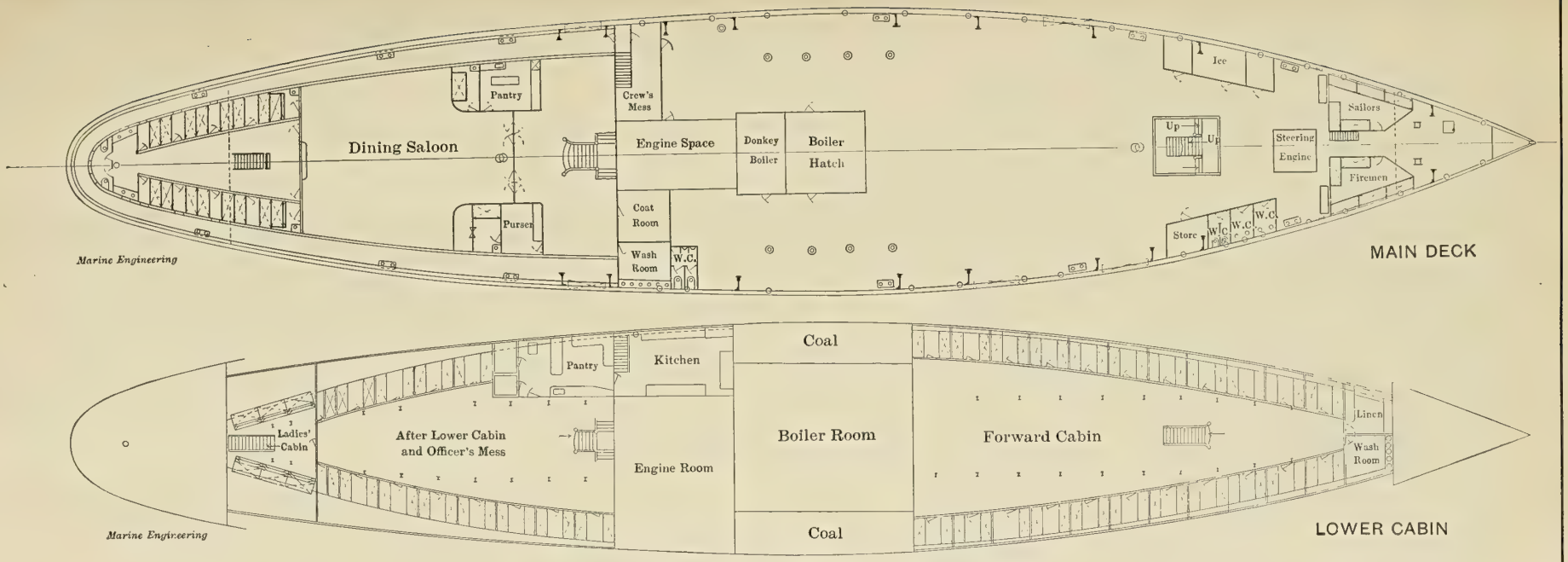
The ship is built according to rules of the United States Standard Register of Shipping and is classed first grade, A 1, for 17 years. A double bottom extends from the forward to the after collision bulkheads. The keel is of the flat-plate type, 36 inches by 27 1-2 pounds. The central vertical keelson is 42 inches by 18 pounds, with double 3 1-2 by 3 1-2 inch by 10-pound angles at the bottom and 3 1-2 by 3 inch by 8-pound angles at the top. The side keelsons are intercostal, and breast hooks are worked at the end of each keelson.

In the wake of the water line the shell plates are increased in thickness for 60 feet aft of the stem for ice protection. The bottom, bilge, and side strakes are from 20 to 25 pounds amidships; the top, sides, and hurricane-deck plating are much lighter. The side stringer with clips and double continuous angles is worked in half-way from bilge to deck beams.





SAIL PLAN AND GALLERY DECK PLAN OF THE STEAMER CALVIN AUSTIN, BUILT BY THE HARLAN AND HOLLINGSWORTH COMPANY. THE LATTER PLAN IS PRACTICALLY THE SAME AS THE HURRICANE DECK.



MAIN AND LOWER DECK PLANS OF THE NEW STEAMER CALVIN AUSTIN.

Frames are 5 by 3 inch by 10-pound angles in one piece to the main deck stringer and spaced 24-inch centers. The reverse bars are on each floor and extend in one piece to the margin plate, while the second part of the bars is riveted to the floor gussets and extends from the margin plate to the main deck. The floors are continuous from the center keelson to margin plate in the engine and boiler rooms; elsewhere they extend only part way to margin plate. Webs are spaced about every eighth frame and run from margin plate to the main deck. There is also a belt at each end of gangways. The main deck is of steel, 7 1-2 pounds, double-bottom plating is 14 pounds, increased in the engine and boiler room, and the foundation plate under engine is 3-4 inch.

Upper-deck beams are of Z bars spaced 18 feet; the main-deck beams are of channels spaced 3 feet, supported where necessary with double 6-inch channel stanchions.

There are 6 steel bulkheads, 4 of which are water-tight up to main deck, where they are fitted with double angle beams. Bulkhead No. 1 is forward collision bulkhead; No. 2 is forward coal-bunker bulkhead—both of these are water-tight and fitted with horizontal and vertical stiffening angles; No. 3 is aft of the boiler room and is not water-tight; No. 4 is aft of the engine room and is recessed into the shaft alley for the thrust bearing; No. 5 is at the after end of the shaft alley and carried to the height of the stringer; the shaft alley here opens through the bulkhead into a space which is flatted over to after collision bulkhead; No. 6 is after collision bulkhead, and is water-tight and stiffened to the main deck.

The stem is of hammered iron 9 by 2 1-2 inches, while the stern frame is of cast steel; the rudder is also cast with a solid blade and is supported from above.

MACHINERY.

The main engine consists of a 3-cylinder, triple-expansion engine, with cylinders 26, 43, and 71 inches in diameter by 42 inches stroke. The cylinders are mounted on cast-iron columns at the back, the condenser forming part of same, and on polished steel columns at the front. Piston valves are fitted to the high- and intermediate-pressure cylinders, and double-ported slide valve to the low-pressure. Pistons are of cast iron, fitted with Christie packing; the rods are 6 inches in diameter; the crosshead slides are of the bar type, made of cast iron; the crosshead is of cast steel, bolted to cast-iron box fitted to bar slide; the bearing surfaces of the box are run with Parsons metal; the connecting rods are forged steel, 94-inch centers.

The condenser is fitted with 3-4-inch brass tubes, while the air pump is of the cross-simple Blake type, cylinders 10, 22 by 15 inches. Sanitary, feed, fire, deck, etc., pumps are of the Davidson type.

The shafting is of solid forged steel throughout. The crank shaft is built in sections 12 3-4 inches in diameter. The thrust is fitted with nine horseshoe collars and is 12 1-2 inches in diameter. The line shaft is 12 1-8 inches in diameter and the propeller shaft is 12 7-8 inches in diameter. Water circulation is provided for main journals and crosshead slides.

The ship is lighted throughout by electricity from two 35 K. W. General Electric generating sets driven by simple engines. Ventilation of the galley and boiler rooms is provided by a Sturtevant engine-driven fan placed on the grating in the upper engine room.

Four single-end Scotch boilers supply steam of 175 pounds pressure. They have a common fire room and coal is handily supplied from wing bunkers. Two large ventilators carry air down to the fire room. Air is also supplied through ducts overhead from the ventilating fan placed on a grating in the upper engine room. The uptakes in the four boilers lead to a common funnel.

On her run to Boston from Wilmington the *Calvin Austin* underwent a successful trial, and the engines developed 2,600 I. H. P., the highest being 3,100, and the speed was 18.9 miles per hour.

Name—Calvin Austin. Nationality—American. Type—Coasting passenger steamer.

Launched—1903. Builder—Harlan and Hollingsworth Co. Owner—Eastern Steamship Co.

Length over all	320 ft.	Revolutions, designed	90 to 100
" between perps	300 "	I. H. P. "	2,600
Beam on water line	48 " 3 ins.	Condensing surf	4 450 sq. ft.
" over guards	62 "	Air pump	Blake
Depth, molded, to main deck	21 "	**Shafting:** Crank, diam	12 3-4 ins.
" between decks	9 "	Thrust, diam	12 1-2 "
Draft, loaded, aft	16 "	Line, "	12 1-8 "
" " forward	10 "	Propeller, "	12 7-8 "
Displacement, loaded	about 2,600 tons	Propeller, diam	15 ft. 3 "
Draft, launching	6 ft. forward by 11 ft. aft	**Boilers:** Number	four single-end Scotch
Speed, load draft	18 miles	Diam	14 ft.
Dead-weight carrying capacity	780 tons	Length	12 "
Tonnage, gross	3,826	Tubes, each	842 3-inch
" net	2,853	Furnaces	3 each; inside diam. 44 ins.
Engines: Number	one	Grate bars, length	6 ft. 6 "
Type	three-cylinder compound	G. S., total	286
Cyl. diams	26, 43, 71 ins.	I. H. P. ÷ G. S.	9.0
Stroke	42 "		
Valves	Piston on H. P. and I. P.		

Costly Mistakes.

The tendency to overlook a glaring error in the search for a trifling one is so old that we are ever warned in Holy Writ in the well-known verse about the beam and the mote. It would seem, however, that in modern engineering the numerous safeguards of the system in an up-to-date works would take pretty good care of such oversights. That this is not true none of us who have ever been employed in such places will doubt for a moment. Frequently errors of this sort are spotted by the careful foreman or mechanic, even when they have slipped past the watchful eyes of the draftsman, the checker, the designer, the chief draftsman, the chief engineer, the general superintendent, etc., and are then mainly useful as an aid to the clumsy wit of the outside man in his efforts to belittle the "white shirts" in the office. Sometimes, though, the error goes right through, and is only brought to light when the erring pieces are finished and assembled; and then—somebody is in trouble.

The writer knows of one case, in a prominent English shipyard, where not until her trial trip was it discovered that a right-hand engine had been equipped with a left-hand propeller! The latter was a four-blade solid casting, and there was trouble for many people, and a great many dollars, or pounds sterling, expended in making things right. In another large foreign yard one of the finest modern English cruisers was building in a rush, and when the engines were erected in the shops it was discovered that the cranks would not clear the columns. There was no time to make new parts, so the columns and cranks were both chipped, with the old hammer and chisel, until they cleared. As this had to be done on twelve columns and six cranks, it is likely that it was not a very cheap job, to say nothing of the weakening of the parts chipped and the additional expense for strengthening them. What her majesty's inspector had to say about the job was not quoted.

For some time the writer was employed as an engineer on a modern 20-knot liner. Her propellers had been giving some trouble, and she was ordered to dry-dock to have new blades fitted, the six blades, of manganese bronze, being put aboard of her in her home port. The dry-dock was a trifle over 3,000 miles from this port, and when she had arrived there, and the six shiny blades had been carefully gotten out, a close inspection convinced the authorities that there were four right-hand and two left-hand blades instead of three of each. There being no time to waste, as she was only allowed a week off the line, three of the right-hand blades were fitted and two of the left-hand. For a third left-hand blade one of the old ones was used with the holes in the boss enlarged so that it could be brought into approximate pitch with the two new ones, the new wheel being nearly two feet coarser pitch than the old. Then she left the dock and went to her berth to load.

A few days later her sister arrived with orders for a similar job; and a careful inspection of her new blades showed that she had been given four left-hand and two right-hand ones. An exchange was made, so ship No. 1 went back into the dry-dock and had the

new blade exchanged for the makeshift. Just what this little mistake cost I do not know; but dry-dock privileges are not of the cheapest. It also takes a good mechanic to distinguish between a right- and left-hand blade of the sort used on these particular ships.

Another ship on which the writer was employed belonged very nearly to the genus tramp. She had a small triple of about 1,200 I. H. P., and by shaking her up and feeding the two firemen and the coal passer a little "Dutch courage" we could, in the current, with a fair wind, get nearly 11 knots out of her. She would have been just about the home the seagoing man yearns for, except for the metallic packing on her valve spindles. This was contained in the usual casing, and just below the casing was the guide bracket for the spindle. This allowed the casing to be dropped such a small distance that it was next to impossible to see anything inside, and all inspection, fitting, etc., had to be done by crooking one's fingers over the edge and feeling around inside. Thus what should have been a comparatively easy job was one of the meanest on the ship. Moreover, there was no necessity in the design of the engine for causing this inconvenience; and we used fervently to pray that the man who made her drawings might be obliged to get out and put in that valve-spindle packing.

During my early seagoing days it was always a mystery to me why chief and second engineers had such a cynical and distrustful way of coming around with lamps and candles, and looking into every cylinder, steam chest, boiler, pipe, etc., that I had opened in port. I discovered why in this wise: An engineer, and an experienced one at that, had taken out the L. P. valve in port. Before closing the chest he had called the second, who approved it. The valve at the time was hanging partly lowered into place. It was a large, flat valve of the trick pattern, and was taken out by means of two 5-8 eyebolts screwed into the top end. It was lowered into place and the chest closed. Before sailing the engine was turned over by a hand-turning gear and everything seemed clear and easy.

Less than twenty miles from port, being still in the river, the engine set up such a row that the chief came down himself and took a card off the low-pressure cylinder. When he looked at the diagram he sent word to the skipper that it was best to anchor, which we did. An investigation showed that the eyebolts had not been removed when the chest was closed; and while they must have cleared at first, as turning her over by hand had been so easy, the subsequent vibration loosened them so that a hole about 6 by 4 inches was knocked into the hollow top of the valve and the loose pieces were caught in the ports—which were bolted on to the cylinder casting, and not part of it—and broken chunks out of them. One of these got over on top of the low-pressure piston, which was a hollow casting, and punched a hole in it and slightly sprung the rod.

Luckily we were not far from shore, so a small boat hunted up a landing and the state of affairs was telegraphed to the office. A tug responded, and the injured piston, rod, and valve were sent away to the shop for repairs. The edges of the broken ports were chipped clean and wooden templates made, from which brass castings were made ashore and put in place with countersunk screws. This was a number of years ago, and the last time I saw the ship these patched-up parts were still giving a good account of themselves. The delay, I think, was just 52 hours, a small percentage of the time usually allowed for the voyage. This turned out pretty badly for the second and the man who did the job but forgot the eyebolts, but it was a beautiful lesson to the rest of us.

More than once since then have I sneaked out the night before sailing and, with a friendly oiler to help, opened up steam chests, cylinder-cover manholes, evaporator doors, *et al.*, on the dread suspicion that there might have been a hammer, or a monkey wrench, an eyebolt, a chisel, a rope sling, or even a stray bunch of waste overlooked when I closed it up. This was especially the case under one second engineer. He had been thriving so on the company's bill-of-fare that one day when he dropped through the manhole in the L. P. cylinder it took two burly firemen and myself to get him out; and when he came he left behind the nether half of his "b'iler suit" and all his peace of mind. He would never go in there again, but instead, upon my reporting that I was ready to close up, would fix a stern eye upon me and go on thus:

"Ye're pairfectly sure ye left no gear in there?"

"Yes, sir."

"Verra well; remimber, I thrust ye absolutely, an' tek yer worrd for it. Away doon and close 'er up, and dinna fergit to swab her oot well wi' cylinder ile and black lead."

TECH.

De Forest Wireless Telegraph.—Several stations of the De Forest Wireless Telegraph Company, which owns the patents of Lee De Forest, an American, are receiving and transmitting wireless messages commercially. The station at Point Judith is transmitting 2,000 words nightly to Block Island, and it is reported that the system works perfectly, no interference from other wireless systems which are in that neighborhood being noticed. The De Forest system, under government tests, successfully transmitted messages at the rate of 52 words a minute, which is far in excess of other systems tested.

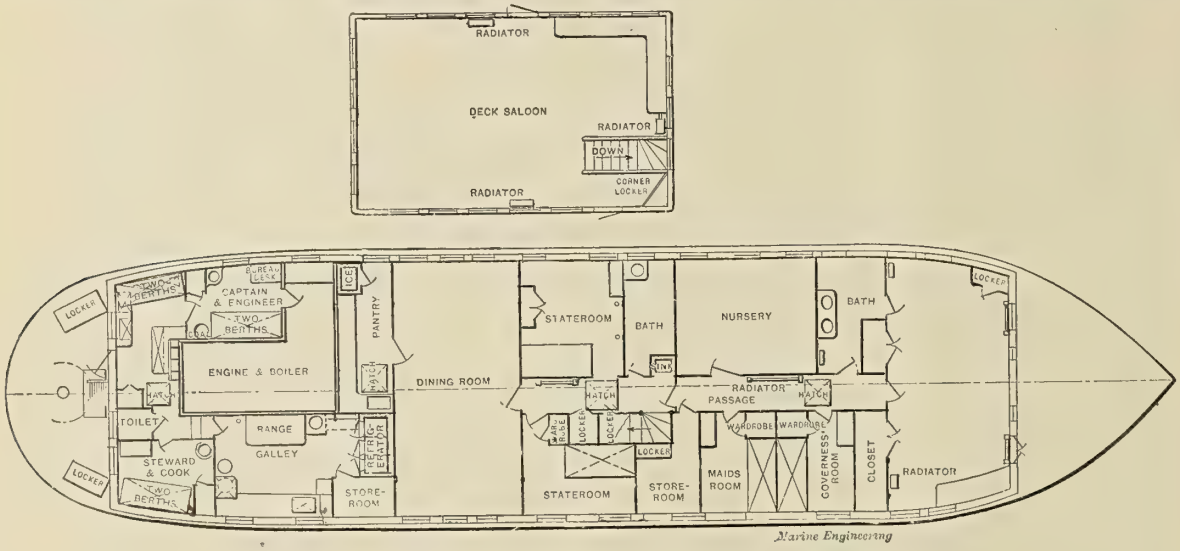
United States Shipbuilding Company's Affairs.—Since the appointing of ex-Senator James Smith receiver of the United States Shipbuilding Company, by Judge Kirkpatrick, there has been continual contention between the reorganization committee and the protesting bondholders. Application was made in each State wherein the shipbuilding company owns properties for the appointing of a receiver, and Judge Putnam, of the United States Circuit Court of Maine, refused to appoint Receiver Smith ancillary receiver for the company in that State. The receiver has signed an order terminating the leases of the subsidiary companies, which leases are terminable at the option of the shipbuilding company on five days' notice. The reason for this was to bring all the properties under the authority of the receiver. Otherwise they would have continued under the charge of the subsidiary companies, over which the receiver had no control. The contesting bondholders claimed that there was no reason for the appointing of a receiver. At the present time the company's affairs are much tangled, and the lines along which the reorganization will finally conform cannot now be seen.

STEAM-PROPEELLED HOUSEBOAT CACHALOT.

THE HOUSEBOAT FOR SUMMER OUTINGS.

The phrase "Necessity is the mother of invention" might be changed to read, "Pleasure is the mother of invention," in this country of ours, for truly it is that thousands of our citizens are daily enjoying pleasures that one looks for relief to the cool breezes of the mountains or seashore for rest and recreation.

The pleasures of the sea have been taken advantage of by increasing numbers, who spend their vacations at either seaside hotel or on board the yacht. To combine the comforts of shore with the pleasures only obtainable on the water there has been brought out of recent years a new style of boat, most properly termed the houseboat. Each year sees a few more of these convenient little craft added to the list.



CABIN PLANS OF THE CACHALOT, DESIGNED BY TAMS, LEMOINE AND CRANE.

which were formerly considered pastimes of a king and are the results of many inventions and years of study. While our engineers have designed efficient means for heating offices and residences, as yet there are no general arrangements for cooling the home or office during the hot summer days and nights; so it is

It is scarcely necessary to dilate on the advantages

of this form of home for spending one's vacation. The modern houseboat is generally provided with an engine for propelling it at a moderate speed along the inland waters of our coast, and thus one's tent may be pitched wherever inclination or fancy dictates.

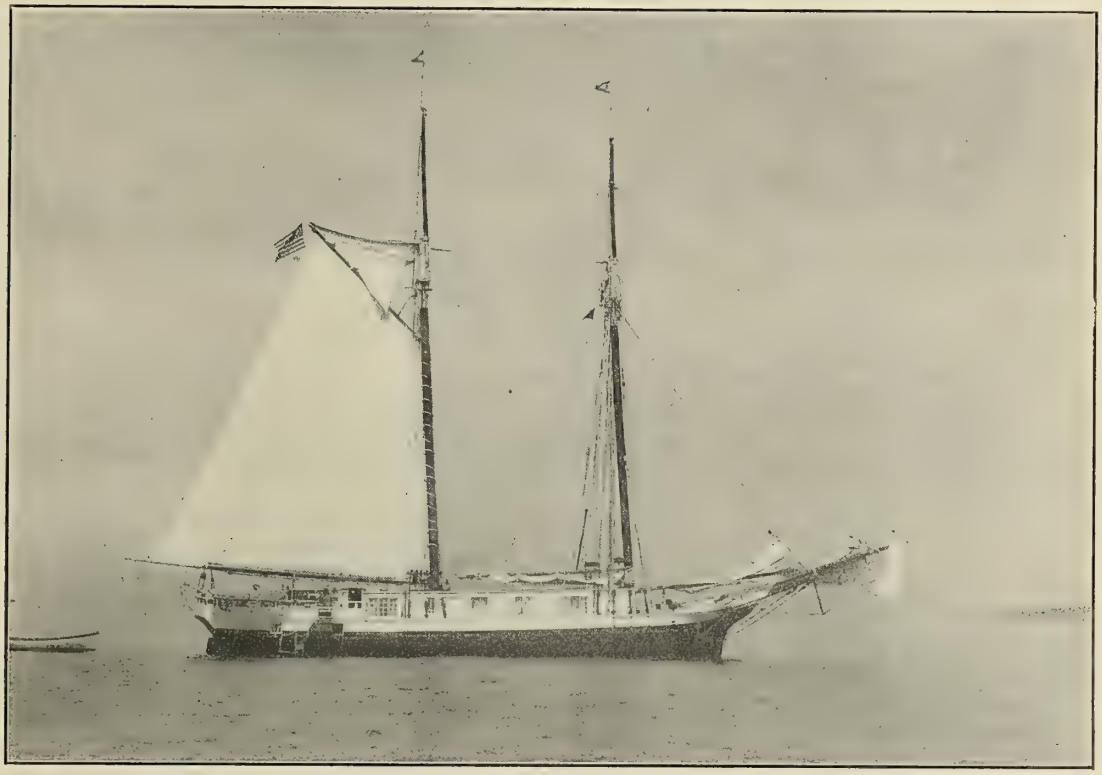
The fundamental design of a houseboat is not that for sailing (or steaming), but of comfortable and economical living afloat. The English houseboat, the predecessor of our type, has no means of self-propulsion other than being fitted with oars. It is not often desired to be moved, and then a tug or a launch is secured. It is used on the small rivers of the island. The conditions here are quite different, for the houseboat is largely used on the salt water, where the owners desire to go from one to another of the many shore resorts on bay or sound.

The price of these boats depends altogether on the size of the purchaser's pocketbook, but for the same amount of money invested in a sailing yacht as in a houseboat the accommodations of the latter are many times larger. A good, comfortable boat can be built for $800, while some of the large, handsome boats cost $25,000 and even more. As the term implies, the houseboat is a house built on a boat; it is impossible to make the craft look shipshape according to the established nautical ideas, and the *boat* is a second though necessary consideration.

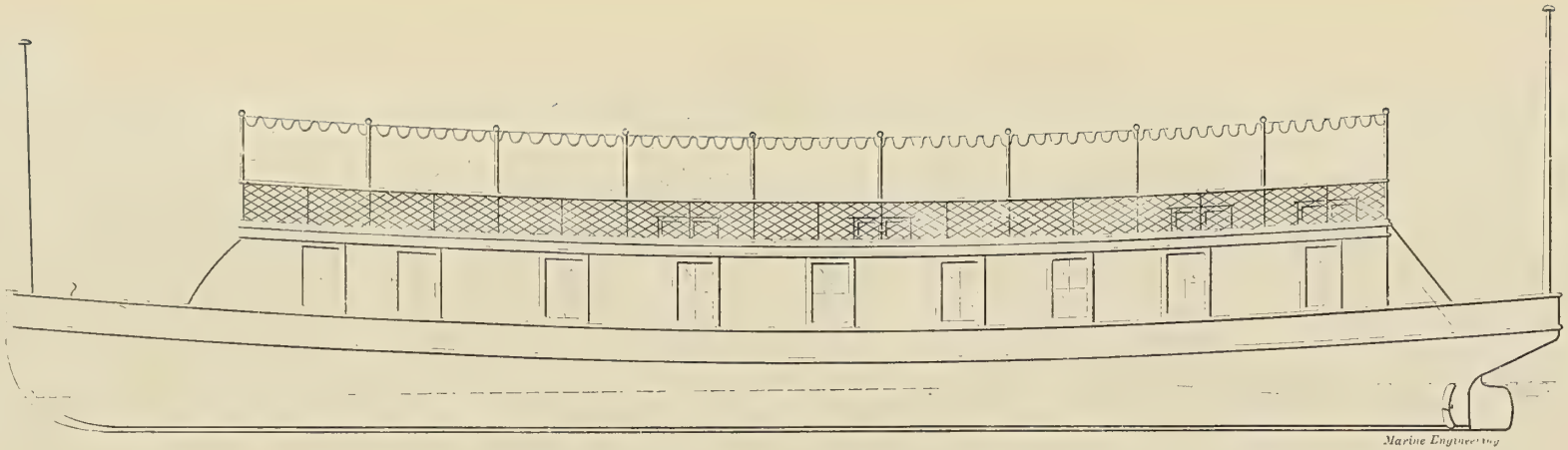
The *Cachalot,* an engraving of which will be found on page 424, shows a high development of this self-propelled type. The boat is 100 feet long over all, 22 feet 6 inches beam, molded, 12 feet depth of hold, and draws 6 feet of water at the stern. She was designed by Messrs. Tams, Lemoine and Crane for a lady and her children, and the contrast between this and that of the *Bonita,* to be described later, shows how successfully plans may be drawn to meet special requirements.

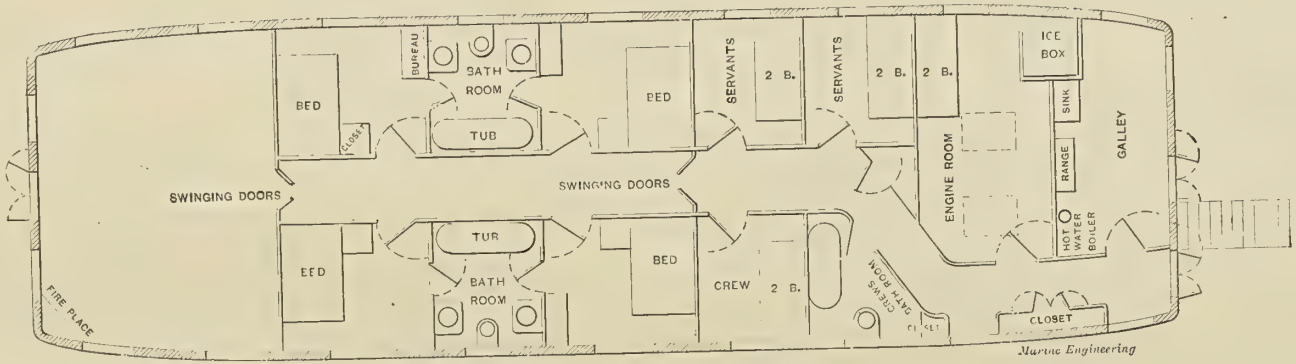
At the forward end of the house is a large room for the owner, 10 feet 6 inches long and the full width of the boat. A passageway leads aft from this room, opening into two bath rooms, nursery, and state room on the port side, and governess' and maid's room, stairway, and state room on the starboard side. Very large closet space is given, and there are two large hatches in the passageway; the hold is exclusively for stores. The after end of the passage opens into a large dining room, 10 feet 9 inches long, the full width of the boat, while directly aft of it are the pantry, store room, and galley. A window opens from the pantry into the galley. The refrigerator is divided up into four compartments, the ice being placed overhead; another compartment being used for general stores, one for milk and butter, and a third for meats. The galley is well equipped with range, dresser, and sink. In the engine and boiler space is placed an Almy water-tube boiler, a compound-condensing engine, and an electric-lighting plant. The captain and engineer have a state room on the port side opening into the engine room and also into the mess room aft. Another state room is placed on the starboard side, and in the mess room are swung two berths. On the deck at the after side of the house a stairway leads above.

In the passageway forward will be found a staircase which leads to the upper saloon, a large room about 30 feet long and 17 feet wide. The quarters throughout are heated with steam and lighted by electricity.



A NOVEL TYPE OF SCHOONER HOUSEBOAT, THE CLARINA.





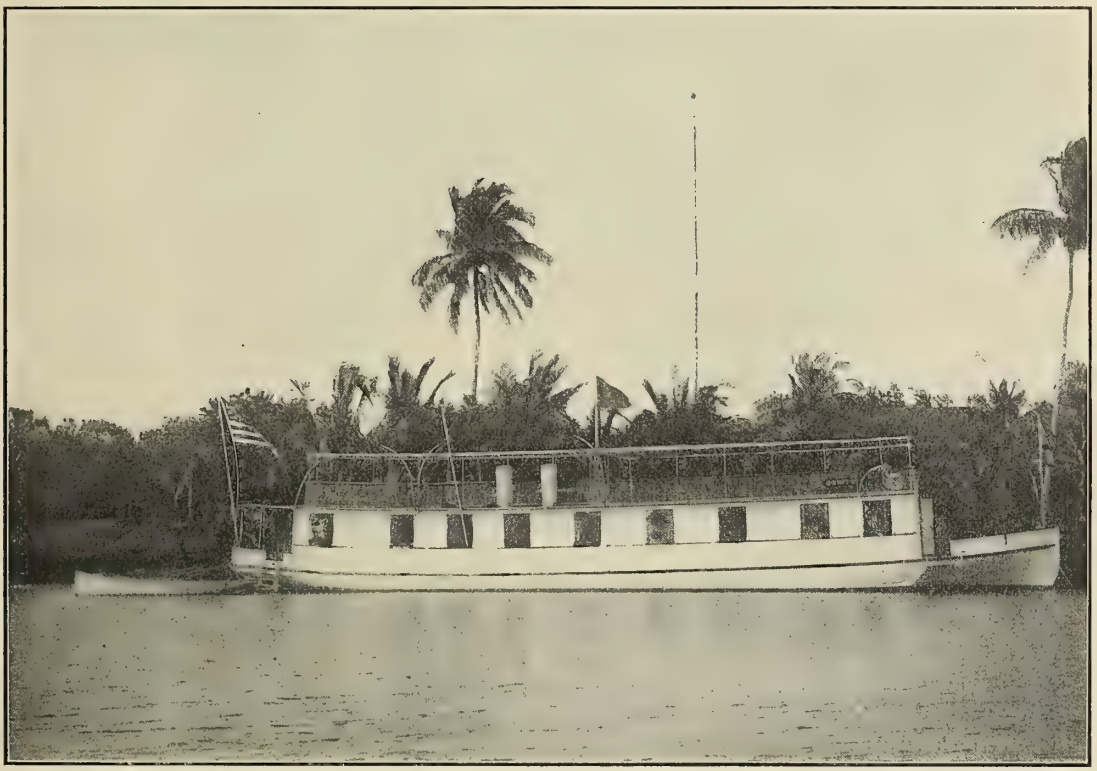
ELEVATION AND CABIN PLAN OF THE BONITA, DESIGNED AND BUILT BY THE MESSRS. OSBORN.

A somewhat similar craft is that owned by General Louis Fitzgerald and now in Southern waters. The houseboat is named the *Bonita,* and was designed and built by the Messrs. Osborn at Croton-on-Hudson, New York. The general dimensions are: length on deck, 100 feet; beam, 23 feet; depth of hold, 4 feet 6 inches; and draft, 3 feet. The hull is framed of oak and chestnut; the keelsons, clamps, and planking are of yellow pine. The main keelson is carried up to the deck with 4-inch stuff, forming a longitudinal bulkhead the length of the boat. The deck is of cypress, and the sides are sheathed to 6 inches above water line with 16-ounce yellow metal. The hold of the boat is used only for naphtha and water tanks, store rooms for provisions and trunks, etc.

It is the house, however, which is the most interesting part of this convenient craft. It is 74 feet long, leaving a forward deck 15 feet and an after deck 9 feet in length, and it is 22 feet wide. The tumble home of 3 inches on each side, the guard projection of 3 inches, and a deck of 6 inches all give the house a good protection for coming into locks or lying at docks, etc.

The windows are fitted with diamond-shaped glass panes, sliding forward and aft, and also each window is fitted with blinds and with wire screens. The upper deck has a galvanized pipe railing and wooden stanchions supporting an awning. This deck is reached by winding stairs forward and straight stairs at the after end. A 22-foot gasoline launch and three 15-foot rowboats are carried on the aft deck, swung on davits.

The arrangement of the house is shown in the plan on page 425. At the forward end is the main saloon, 16 feet long and the full width of the house, with a corner fireplace. A passage 4 feet wide leads aft from this saloon through swinging doors, and from it open off four large bedrooms 8 by 10 feet. Between the rooms on each side is a large bath room, with connecting doors to the two rooms. Each bath room is 7 by 10 feet, contains a large tub, two basins and closet, the plumbing being of modern sanitary type. The tubs are supplied with hot and cold fresh water and cold salt water. The doors at the after end of this passageway lead into the crew's or servants' space, there being three 2-berth state rooms, a bath room, and several large closets.



TWIN-SCREW, GASOLINE-PROPELLED HOUSEBOAT BONITA.

In the engine room are two 25 horse-power Globe gasoline engines, each driving a 30-inch screw, and in one corner of the room are two berths. The gasoline for the engines is stored in copper tanks at the extreme bow, the space being bulkheaded off from the main hold. A galley, 9 by 14 feet, is at the after end of the house, fitted with range, sink, dressers, hot-water boiler, ice box, etc.

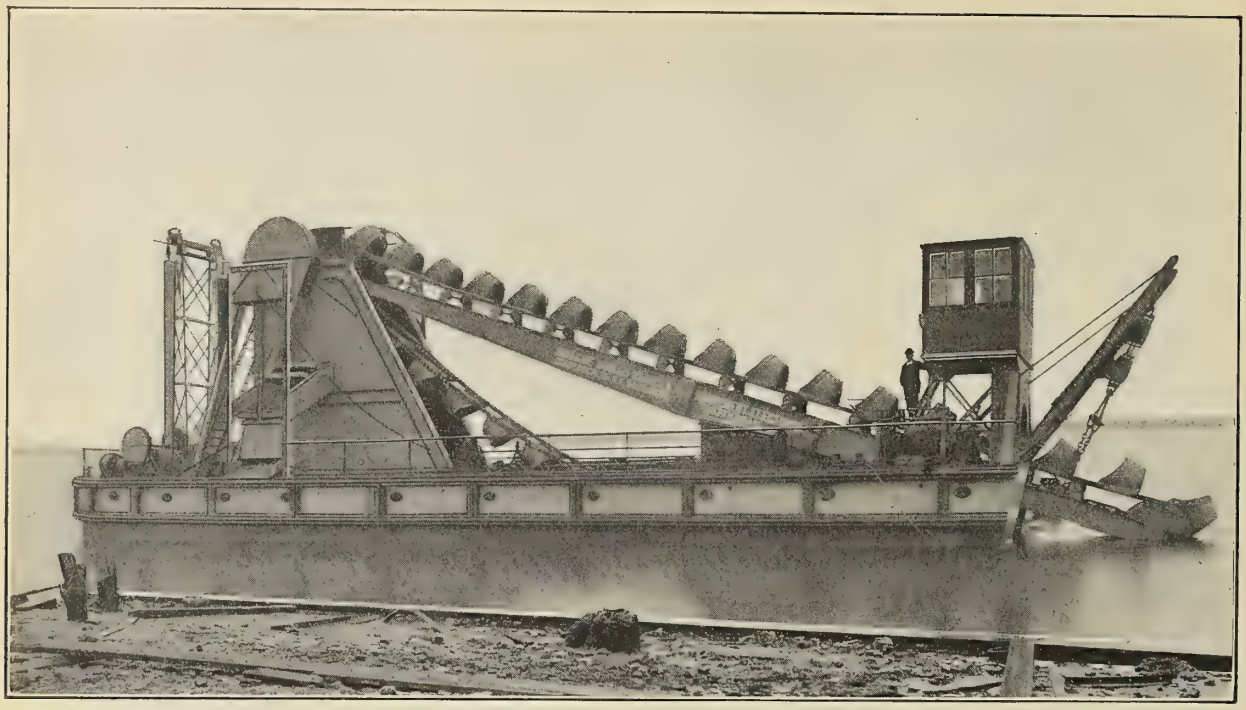
This boat can be driven at a speed of about 8 miles an hour, and thus, it will be seen, almost reaches the cruising class of yacht.

A third and simple type of houseboat is illustrated on page 425. Here the owner has taken a two-masted schooner and built a comfortable large deck house between the masts. The boat does present an unusual appearance with its clumsy deck house and its bay windows, but comfort is the keynote of this class of boat, and in all the designs light and airy quarters, large cabins, and plenty of head room have been secured.

Before closing some mention should be made of the floating hotels which a philanthropic capitalist of New York equipped and ran two summers ago. These consisted of old sailing vessels made over, with many sleeping rooms. Those who wished to rent a room on board for the night were carried from the city in special tugs, placed on the floating hotel, and these latter were towed down the bay and anchored near Sandy Hook until early the next morning, when they were towed back to the upper harbor. The season in which they were started was an exceedingly warm one, both afloat and ashore, and the discomforts of the floating hotel were almost as great as those ashore. It was not a popular venture, and the boats have since disappeared.

The houseboat is bound to increase in popularity, especially with those of moderate means, for with what a man with a good-sized family would pay for board at a summer hotel he can build and equip one of these boats and be independent of hotel proprietors or land agents, and he may change his camp without even packing a trunk.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 140 vessels of 48,166 gross tons built in the United States and officially numbered during the month of June, 1903. The largest steel steam vessels included in these figures are: *James H. Reed,* 5,598 gross tons, Wyandotte, Mich.; *D. M. Clemson,* 5,531 gross tons, West Superior, Wis.; *Sonoma,* 4,539 gross tons, West Bay City, Mich.; *B. Lyman Smith,* 4,271 gross tons, Lorain, Ohio; *Calvin Austin,* 3,826 gross tons, Wilmington, Del.; *Larimer,* 3,737 gross tons, Camden, N. J.



ELECTRICALLY-DRIVEN LADDER DREDGE, FOR USE ON THE RIVER ESLA, IN SPAIN.

ELECTRICALLY-DRIVEN LADDER DREDGE.

The type of ladder dredge constructed from the designs of Mr. Bunau-Varilla by the firm of A. F. Smulders, Rotterdam, Holland, is in use for dredging ballast on the river Esla, near Benevente, in the province of Zamore, Spain. The chief point of interest in this dredge is in the fact that it is electrically driven throughout.

The current is generated at a high pressure at some suitable point on the river bank, and conveyed to the dredge by means of overhead wires or suitably protected subaqueous cables. The same generating station also supplies the power needed for working the conveyer by means of which the ballast received from the dredge bucket is transported and tipped into the ballast wagons.

The general appearance of the machine is well shown above, whilst the details of construction will be understood on referring to drawings on the following page.

An entirely novel system of anchoring the dredge, and of traversing it and moving it forward, has been adopted, since no anchorage or mooring chains are used, the sole connection between the river banks and the dredge being the electric cable, so that the free movement of other vessels up and down the stream is unimpeded, even while the dredge is at work. The method of procedure is as follows:

The proper position for beginning work having been attained, a heavy pile is sunk through an opening purposely left in the bow of the boat (see drawings), and driven into the river bottom, thus forming a fixed point about which the vessel can swing. This swinging is effected by the electrically-driven screws shown at the stern of the boat.

Trials made in the Meuse on February 4, 1896, showed that the dredge could be kept up to its work, broadside to the full tidal current, with only one of the two screws in action. The buckets came up full, the work being carried out without the slightest hindrance, although the start was made on entirely new ground.

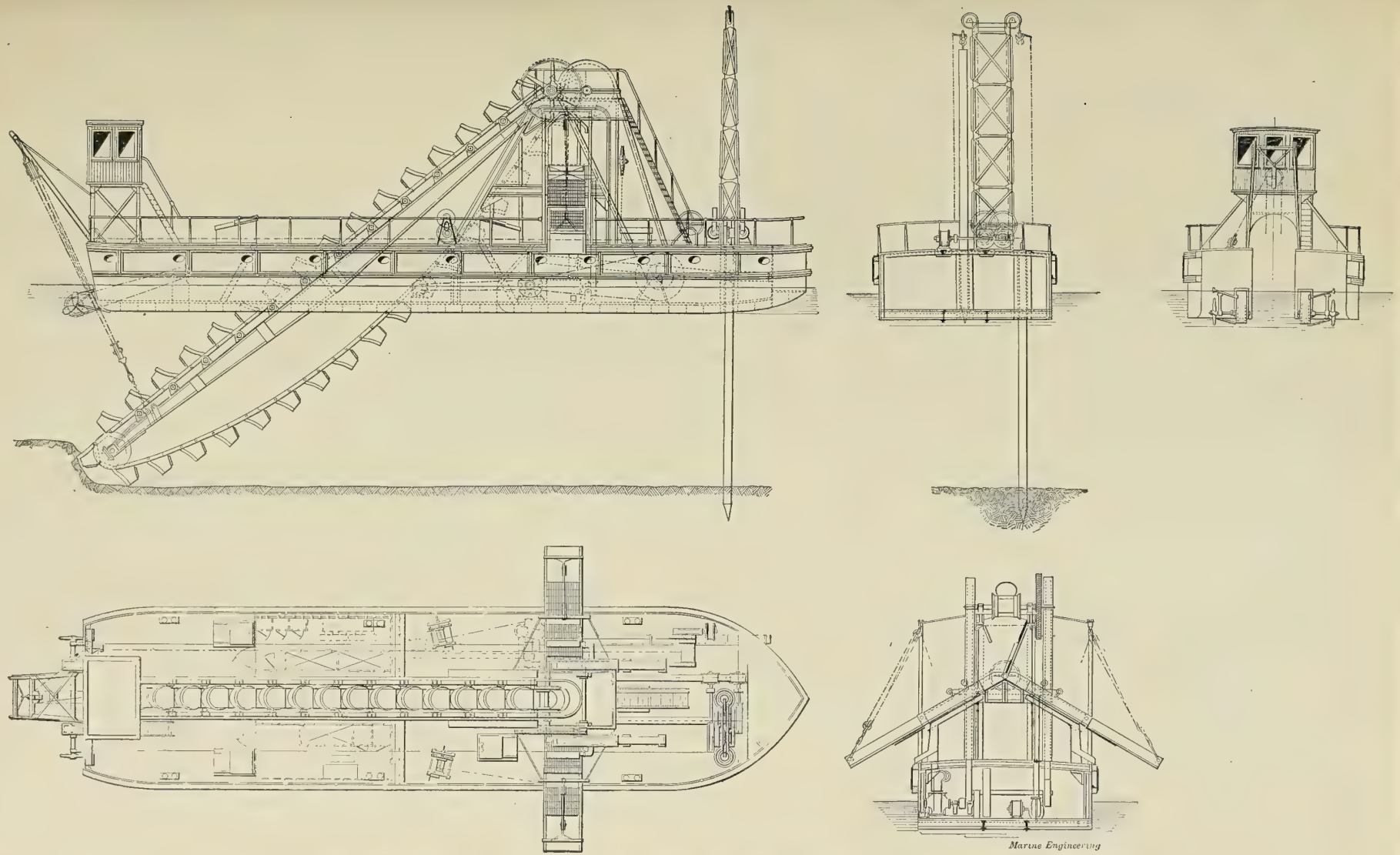
The method of advancing the dredge to a new position is equally novel. As will be seen, a second pile hole is placed near the bow of the boat at a distance of 6 1-2 feet from that previously referred to. In shifting to a new position the dredge is swung at an angle to its desired course, and another pile is then driven down through this second hole; the first pile is then lifted and the dredge is swung back till the central pile hole is over a point in the channel some feet in advance of its previous position. The central pile is again lowered and the side pile withdrawn, after which the work of excavation goes on as before.

The piles are made of steel tubing, and are heavy enough to enter an ordinary river bed by their own weight, whilst in the case of very hard ground they may be filled with lead. The lifting and lowering of the piles is, like all the other operations of the dredge, controlled by a single attendant, all the necessary switches being grouped in the cabin shown at the stern of the boat.

The chain of buckets is driven by a three-phase motor of 30 K. W., which, however, is capable at a pinch of developing 50 per cent. overload. It is, like the motor working the pile gear and the ladder crane, designed to run at 600 revolutions per minute, the necessary reduction in speed being effected by gearing.

The operations of starting and stopping can be effected with great rapidity, and the speed when running is perfectly constant.

The torque exerted varies greatly as the buckets pass over the tumbler. Running empty, the current, taken



PLANS, ELEVATION, AND SECTIONS OF AN ELECTRICALLY-DRIVEN DREDGE, BUILT BY THE FIRM OF A. F. SMULDERS, OF ROTTERDAM, HOLLAND.

as the bucket rises over the latter, corresponds to 27 K. W., while when the summit is passed the current falls to zero. With a full bucket the ordinary maximum effort corresponds to about 40 K. W., so that the average demand may be taken as 20 K. W. only, thus leaving a very large reserve of power. Should, how-

ever, the resistance met with exceed the maximum power available, the fuse on the motor circuit blows, thus saving the apparatus from damage. The replacement of this fuse is, of course, only a matter of a few minutes.

The generator selected delivers to the mains a triphase alternating current at 2,000 volts. This is transformed on reaching the dredge to a 200-volt current, with which the different motors are designed to work. These are seven in number, two being employed for driving the screws, one for lifting the ladder, one for driving the chain, two for the pile gear, and one for a centrifugal pump, the discharge from which is used for washing the ballast free from sand.

CURTIS STEAM TURBINE.

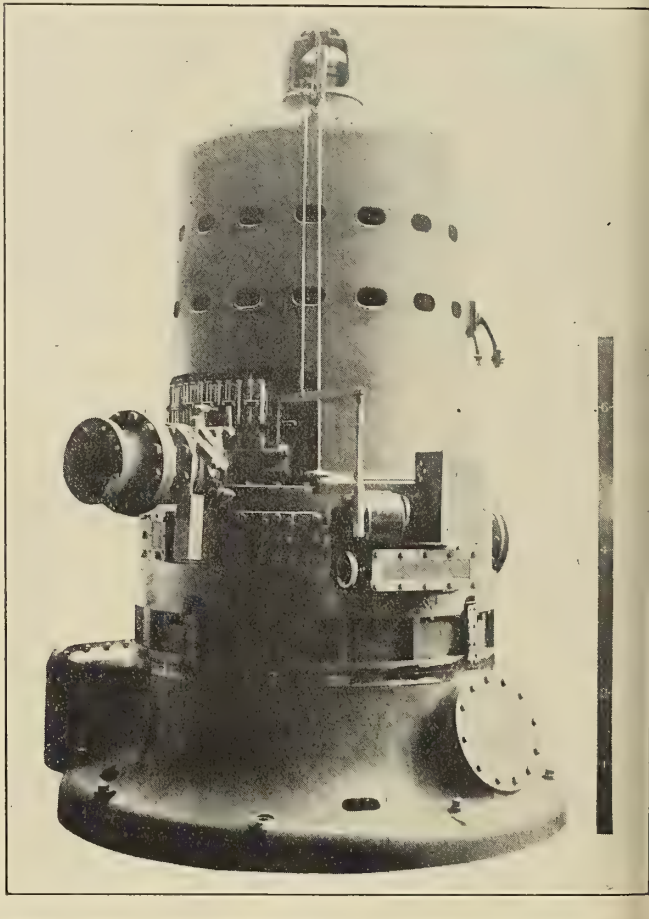
That the steam turbine has quickly assumed a prominent place in steam engineering can be attested by orders which the different manufacturers have to-day on their books for this form of prime mover. The steam turbine was practically unknown until a few years ago, and it is only within the last three years that it has been used at all in this country commercially; while to-day it is estimated that there are many hundred thousand horse power of steam turbines under manufacture. It is well known that the first form of steam engine, the old Hero engine, was that of a steam turbine; but for many centuries this type was set aside, and under James Watt the reciprocating engine was developed.

The two general principles on which different turbines have been constructed are: First, transformation through a nozzle of the potential energy of the steam into kinetic energy of motion; thus the steam is expanded from boiler pressure to the exhaust pressure in a carefully designed nozzle where all its energy is transformed into energy of motion. Steam at 150 pounds boiler pressure exhausting into a 28-inch vacuum will attain a speed of over 4,000 feet per second. In the De Laval type turbine the steam impinges on a series of radial buckets on a disk, driving the latter at a very high speed. Theoretically 100 per cent. efficiency would be obtained with the vanes traveling at one-half the velocities of the steam; practically this speed in the De Laval turbine has been reduced to about 1,200 feet per second. The rotating member is supported on a light shaft resting in double spiral gears to reduce the velocity 1 to 10.

The other general principle on which turbines are built is that of the expansion of the steam in the turbine, similarly in principle to that of the steam engine. The Parsons turbine embodies this principle. The steam enters a long cylindrical casing in which is a rotating cylinder with successive series of blades mounted radially upon it. The steam first strikes the blades on the rotating member, then the blades on the casing, then the second series of blades on the rotating member, and so on, back and forth, throughout the length of turbine. Expansion takes place at each set of blades, and the steam is exhausted in the condenser. It is usual to divide the cylinder into three parts, called the high-, intermediate-, and low-pressure stages, the high being the smallest, the intermediate larger in diameter, and the low still larger in diameter.

With these brief general remarks as to the types of turbine, we now pass to the Curtis turbine, patented by Mr. C. G. Curtis, of New York. It embodies a combination of the above-mentioned principles. Steam at, say, 170 pounds pressure, absolute, is expanded in several nozzles to about 20 pounds pressure, absolute, and this amount of potential energy changed into kinetic energy is abstracted fractionally, that is, by a series of wheels fitted with buckets. When the steam has thus given up its velocity, the potential energy is again transformed into kinetic energy by expanding in a second group of nozzles, and the energy as far as may be is turned into velocity, which velocity is again abstracted fractionally by a second series of wheels.

Briefly described, the Curtis turbine consists of three



CURTIS TURBINE, DIRECT-CONNECTED TO A 500-KILOWATT GENERAL ELECTRIC GENERATOR.

or more revolving disks of rolled steel with buckets cut radially into the periphery of each disk. The disks are mounted on one shaft, placed in a casing. The sides of the casing about the disks are removable, and have attached to their inner surface rows of stationary buckets arranged to fit in between the revolving disks, and the inclination of the surface of these buckets is reversed to those of the revolving members. Steam enters through several nozzles, arranged opposite to the stationary members, and is discharged against the buckets of the disks at a high speed. After passing through one disk the steam is caught by the stationary buckets, its direction reversed and thrown against the second revolving disk, and the operation is repeated by

each set of stationary and revolving members until its kinetic energy has been removed and it is led into the condenser.

The Curtis turbine is generally divided into two or three stages. In the usual two-stage type there are three revolving disks for the first stage, with one set of nozzles; steam then passes to the nozzles of the second stage, which is larger in diameter and has longer buckets of different pitch than those of the first stage. Expansion in the high-pressure nozzles is from boiler pressure down to about atmospheric pressure, while in the low-pressure nozzles expansion is down to vacuum. In the low-pressure, the nozzles and stationary members are placed throughout the circumference of the casing, while in the high-pressure there is but one set of nozzles.

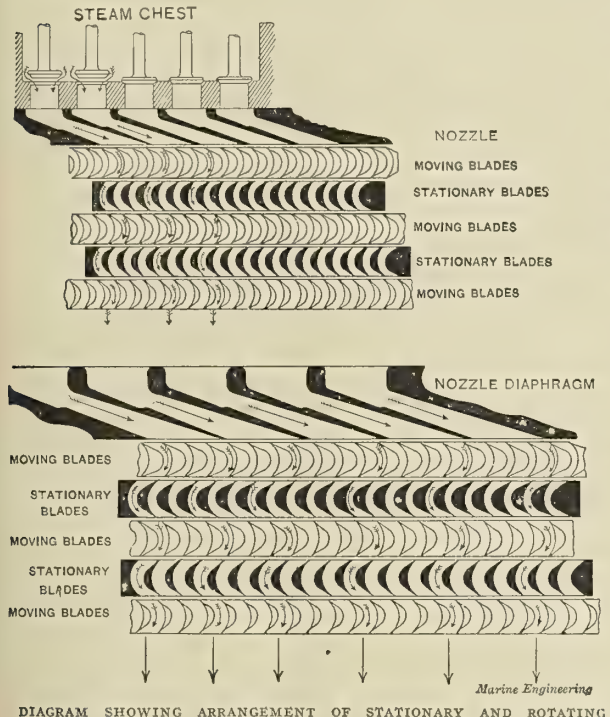


DIAGRAM SHOWING ARRANGEMENT OF STATIONARY AND ROTATING BLADES ON THE CURTIS TURBINE.

One of the chief points of interest in this turbine is the unique form of regulation. A nozzle is designed to work with maximum efficiency under one set of conditions, viz., volume and pressure. Should these be changed through throttling the efficiency is greatly reduced. In this turbine the nozzle is either wide open or closed in the high-pressure chest. Regulation is by an inertia governor, placed on top of the shaft, which, through electrical contacts, will close or open one or more nozzles as the load decreases or increases; thus each nozzle is running at its maximum efficiency.

By the use of superheated steam the efficiency is greatly increased, which is doubtless due to re-evaporation of the water of condensation which may take place in expansion.

The rights of the Curtis turbine for electric-power generation are owned by the General Electric Company, and the form of turbo-generator is illustrated on page 430. The generator and turbines are mounted on the same vertical shaft, which is supported under an oil- or water-cooled step bearing; the liquid being forced in under pressure, the clearance between the revolving and stationary members is small, but leakage is slight, as there is but slight difference in pressure between the steam-jet and casing pressure.

The generator is placed at the top, the high-pressure is next below, and valves for opening and closing the nozzles may be seen just above the steam connection. The low-pressure with removable segmental casing is seen adjoining below. The exhaust is taken to surface condenser, at the back of the picture. The governor is mounted on top of the shaft and the rod for operating the valve is shown in the view.

At present the General Electric Company states that it has altogether machines of 300,000 K. W. under contract for driving electric generators. The largest is 7,500 K. W.; others are 5,000 K. W., 2,000 K. W., and 500 K. W. In point of size these turbines are about one-twentieth that of a reciprocating engine with its generator, with about one-eighth the weight, exclusive of foundations. Running at a high speed, 1,500 R. P. M. for a 600-K. W. size, permits of a much smaller generator. The efficiency curves, published by the company, give a water rate with saturated steam of 19 pounds per K. W. at full load. With steam superheated 150 degrees Fahrenheit the water rate is reduced nearly 2 1-2 pounds per K. W. The efficiency gradually decreases with increased steam pressure from 21 pounds of water per K. W. at 107 pounds steam pressure (gage) to 18 1-2 pounds at 200 pounds steam pressure. This is with saturated steam. The curves of water rate with saturated steam and with different vacuum pressures show a marked increase in economy for high superheat and low vacuum.

This type of turbine is doubtless capable of several different applications. The marine type has already been experimented with, and for the last year and a half the steam yacht *Revolution* has been in service equipped with this turbine. Of course, the machine is mounted on a horizontal shaft forming part of the line shaft. About 2,000 horse power has been developed on this boat when running at 700 revolutions per minute. The great objection to former types of turbine for marine propulsion has been the impossibility of reversing without installing separate turbines. In the Curtis this objection is overcome by placing on the shaft a separate disk with blades reversed from those of the go-ahead type. In a later article Marine Engineering trusts to present the marine type to its readers.

Heating Value of Alcohol.—At the official laboratory of Austria some new experiments have been carried out on the relative heating value of gasoline and denatured alcohol. For motive purposes a pair of nominal 8-horse-power engines, one designed for alcohol and one for gasoline, were compared. The gasoline had a specific gravity of 0.7 and a calorific value of 7,700 calories per liter; the consumption per horse power was 340 grammes. The alcohol was of 90 per cent. strength and had a calorific value of 4,900 calories per liter; its consumption was 373.5 grammes per horse-power hour. The efficiencies were, therefore, 16.5 per cent. for the gasoline and 28 per cent. for the alcohol.

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INCREASE in the size and power of ships has usually gone forward with relatively small steps. The gradual development during the past 15 years, or covering the period from the *Majestic* and *Paris* class to the *Deutschland* and *Kaiser Wilhelm II.*, has been by steps of only a few thousand tons in displacement and a few thousand I. H. P. in power. In all such cases, and throughout the development covered by this period, the steps have not been so great but that the new ship might be fairly said to be in the same general class with her predecessors, and her general relation to the conditions of service might be fairly predicted by a simple extension of the qualities of the ships immediately preceding.

This is not altogether the case with the new Cunarders which are at present exciting so much interest in the maritime world. These ships as projected represent so long a step in advance of anything at present afloat that they can hardly be considered as belonging in the same class. The increase in length, beam, and displacement is not so extreme. A length of 760, beam of 85, and displacement of 35,000 tons means an increase of some 60 feet in length, 10 feet in beam, and 5,000 tons in displacement. These are not so great as to take the ships quite out of existing types. In power and speed, however, the increase is much more pronounced. A total I. H. P. of 70,000 represents an advance of some 30,000 beyond the front rank of existing practice. Likewise speed, which has crawled upward by fractions of knots, here takes a step of two or three knots. A trial speed of 26 knots and a sustained speed of 25 means an enormous advance in this respect—a step indeed corresponding to the advance in power, as already noted. In connection with the question of dimensions it is interesting to note that the earlier designs all contemplated a beam of some 76 to 78 feet, and it was not until these models had been subjected to tank experiment that it was decided to increase the beam to 85 feet, as noted above.

With these advances beyond existing ships it may be questioned to what extent the relation of the qualities of the ship to the conditions to be met in service can be satisfactorily predetermined. Mere size and speed are, of course, not to be considered as ends in themselves. There are also questions of harbor and terminal facilities, the maintenance of channels, and in general the problem of terminal navigation, all aspects of which present increased difficulties with increase in size.

Again, speed should have some reference to the length of route and proposed schedule of sailing, in order that the times of departure and arrival may both be in daylight. On a 2,800-mile run a speed of 25 knots would require 4 days and 16 hours, which might or might not fulfill this requirement, depending on the time of sailing. All this, however, has doubtless received full consideration, and the company will undoubtedly know how to use such ships to the best advantage. So far as the general qualities to be expected from increased size, the four of most importance are probably: the increased economy with which high speed may be attained with increase in size; the increased economy with which freight may be carried with increase in size; the general increase in steadiness and comfort for the passengers; the increasing regularity in speed and the possibility of a nearer approach to a regular schedule of time for arrival as well as for departure.

Regarding the attainment of high speeds, it is well known that below a certain size the attainment of a given speed is impracticable, and,

in fact, the realization of a given speed imperatively calls for at least a minimum size. In the present case it is understood that the size was a more or less direct outcome of the condition expressed in terms of speed. Along the same line it follows that for a given speed the minimum size is required before any freight whatever can be taken. Beyond this point the proportion of freight to total displacement rapidly increases, and the expense decreases in corresponding proportion. The increasing steadiness and comfort are qualities of which it is difficult to express the money value, but the value is none the less real and will go far in determining the choice of route or the price which the passage will bring. It is too much at present, in any event, to hope for any great regularity or approximation to a schedule in arrivals at port, but in fair weather and with ships of this size a much nearer approach may be looked for than with ships of present-day size.

The design and construction of these ships is a project of great independence and boldness and one which will be watched with the greatest interest by the entire maritime world. Time alone can determine whether the combination of characteristics is such as to render them to the best possible degree suited to the commercial and economic requirements of the next few years.

ELSEWHERE in this issue will be found a description of a new type of turbine of which until recently but little has been generally known. The Curtis turbine has been the subject of experimentation for several years past, but now it is being sold commercially for the purpose of electric-power generation. The advantages of the steam turbine over the reciprocating type of engine are, as has been previously stated in these columns, very many. First in point of design is the simplicity of the machine, free from reciprocating parts or packed joints; then, because of the high speed of revolution, its size and weight are greatly reduced. A uniform turning moment on the shaft, resulting from the constant flow of steam through the nozzles, reduces vibration to a minimum. Second is the economy which is possible with this form of engine using superheated steam. The degree of superheat in reciprocating machines where lubrication is required is limited; but in the turbine the superheat may be carried to a point only limited by the form of the generators. Superheat prevents condensation due to the expansion of the steam or from radiation, and the marked increased efficiency with superheated steam, as shown in the curves published by the various makers, is accountable from the fact that the friction between the turbine revolving at such very high peripheral speeds and its surrounding medium varies according to the density of said medium. Recalling that this type of engine was introduced but a very few years ago, the extent of its present use is almost phenomenal, and its ultimate successes and replacement of the reciprocating engine in certain fields is assured. Many of the problems have already been solved, and engineers throughout the world are at work to perfect the present machine. It is eminently suited for small-plant work, for the economy of a small turbine is expected to be practically as good as that of the large machines, which is not the case with reciprocating engines. Gradually we see that specific types are being evolved for the various purposes, and already the Parsons turbine is commercially used with success for ship propulsion. Absence of vibration especially recommends the turbine for this service, and though the progress in this line has not been marked with such swiftness as it has in stationary work, possibly because of the conservativeness of marine engineers to adopt any fundamentally novel machine, we may confidently look for marked changes in the type of engines in our merchant and naval vessels.

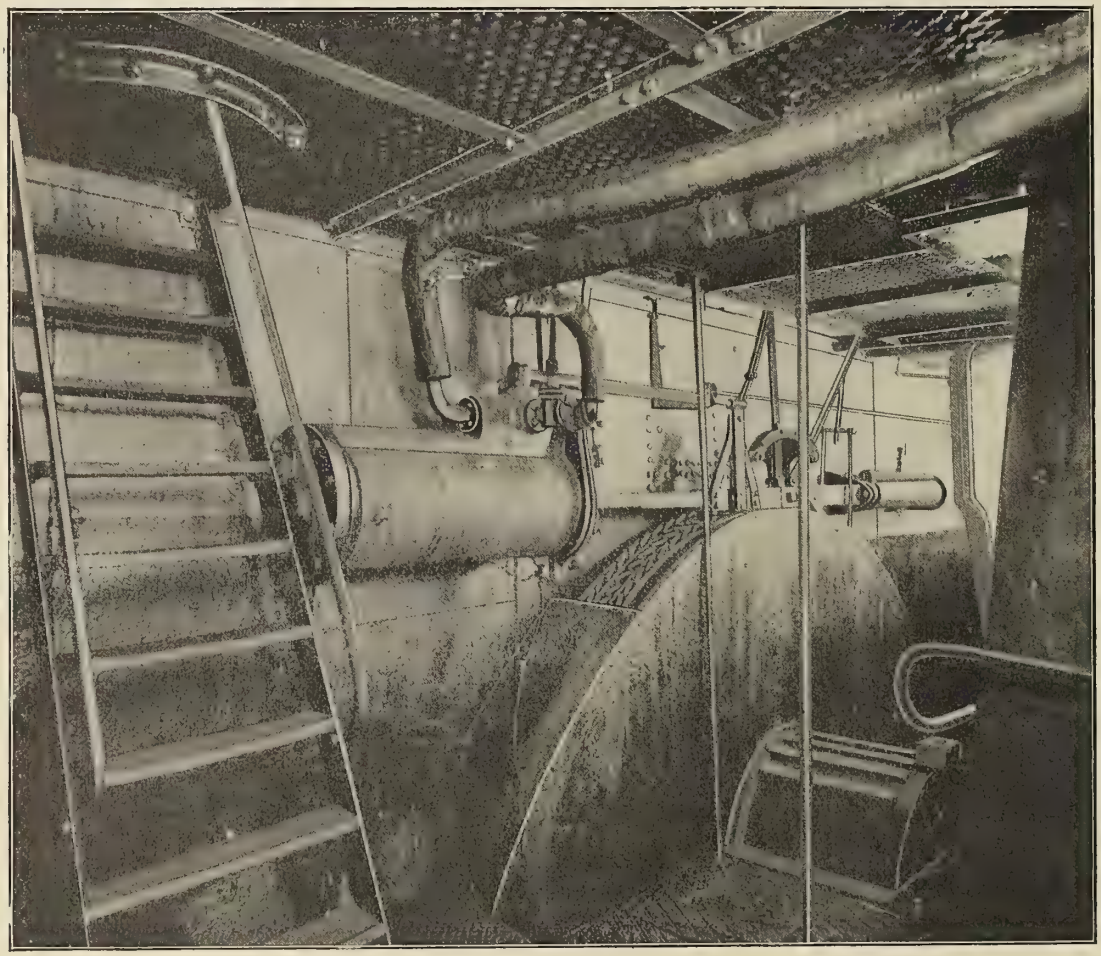
NO doubt those interested in marine engineering will read with interest the series of articles on "Electricity on Shipboard," the second chapter of which appears in this issue. The fact that practically all marine installations have been made in the last twenty years is one scarcely realized by the present-day engineer. The development of the electric plant on board ship, especially in naval work, has been most marked. At first electricity was used simply for lighting and on the low-voltage system; now single installations of several sets, amounting to over one thousand kilowatts capacity, are found on our large warships, electricity being used for operating all ammunition hoists, turning the turrets, and for many auxiliary purposes. The writer of these articles, from the great fund of information at his command and his long experience, is well qualified, not only to record the past and present practice in this field, but to give much of practical value to this constantly-developing subject.

A Curious Old Ship.

A freight and passenger steamer, running from the port of New York, built in 1874 at Newcastle, England, combines some interesting and quaint ideas of engineering and shipbuilding. In the first place, the ship is one of those long, narrow vessels with no steel superstructures, her general dimensions being: length, 350 feet; beam, 37 feet (giving ratio of length to beam of 9 1-2 to 1); and 27 feet 8 inches deep. She has seen long service in her trade, but her last voyages have been run at a speed equal to that made when she first came out.

Stepping on the main deck one is struck by the absence of poop, bridge, or forecastle, there being a clear deck from stem to stern, the only obstruction being wooden deck houses amidships and aft. Amidships, on either side, is a teak house with quarters for the officers, and on the center line amidships is a galley. Aft of this is a donkey boiler and the fidley grating and stack. The boiler is mounted in the open (in fact, there is no deck extending over from the side houses, except the bridge), and is of the cylindrical type, fired from the starboard end; its stack is led up along the forward side of main stack. The bridge is on the top of the galley at the forward end of side housings, so it is evident that it is not a very dry spot in rough weather. Continuing aft is the engine-room casing of wood, and at the stern is a long deck house, a dining room for the first cabin, the other accommodations being on the deck below. This dining room is curiously trimmed with white marble panels and pilasters. The stairway at the forward end of the house leads down to the above-mentioned rooms, and is fitted with cast-iron railing and posts.

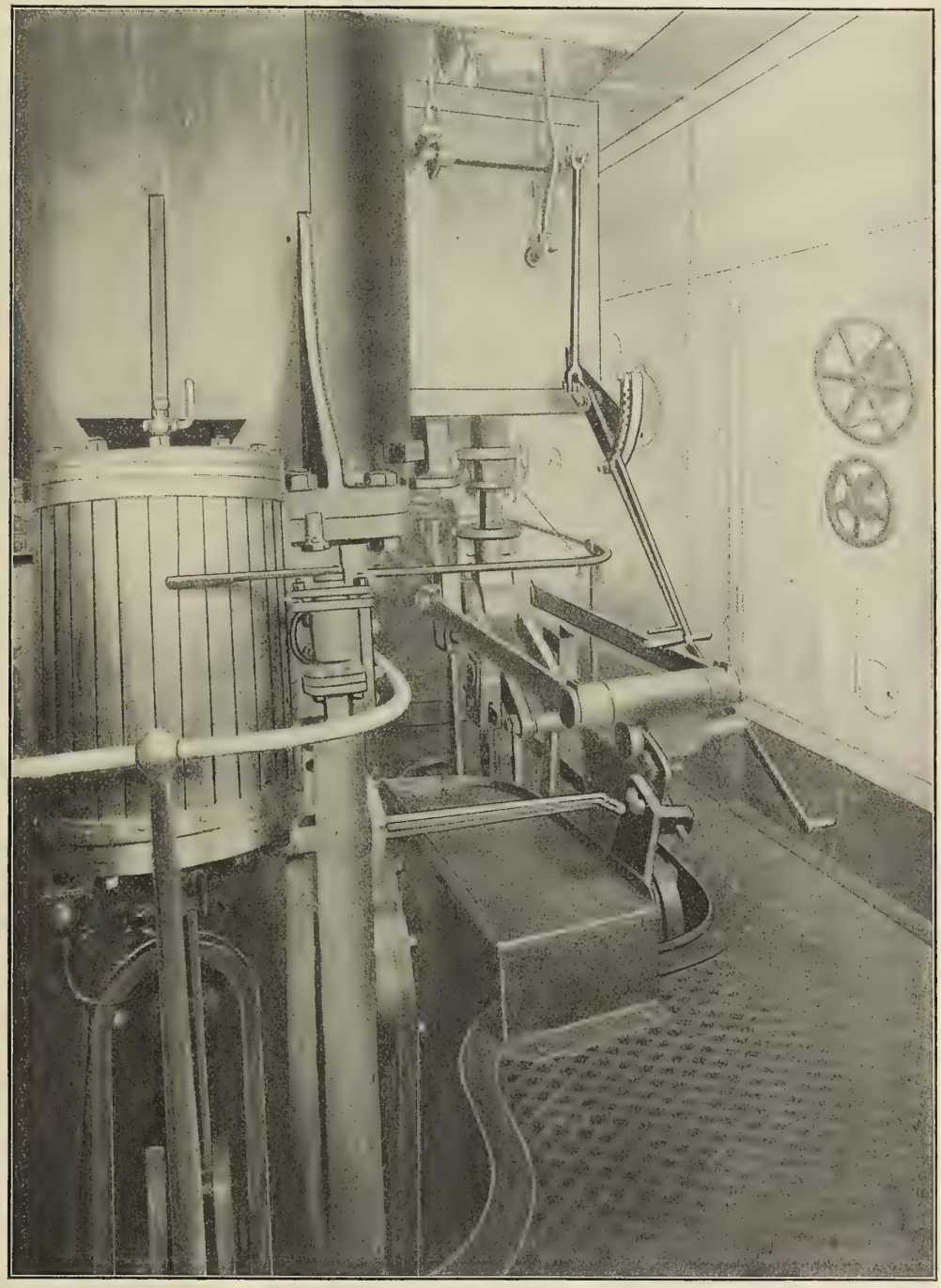
It is in the engine room, however, that one finds the most interesting features of the "curiosity shop." Here is a steeple-compound engine with cylinders 36 and 76 inches diameter and 51 inches stroke. The high-pressure is mounted on top of the low-pressure, both cylinders having slide valves on the forward sides. A few steps down from the deck land one on the upper grating, and from the second grating the engine is operated. Two eccentrics give motion to the low-pressure valve, which has a through-stem to which is attached a rocker arm for operating the valve of the high-pressure. Reversing is accomplished by a steam cylinder laid vertically on the starboard engine column, and the throttle valve is within reach. The valve stem of the low-pressure is guided below the eccentric block, thus requiring very long-forked eccentric rods. The engine is mounted on cast-iron columns, one front and one back, in the latter of which is built the condenser



FLYWHEEL AND TURNING GEAR ON AN OLD MARINE STEEPLE-COMPOUND ENGINE.

Steam is carried through a jacket on the low-pressure into the column to the condenser.

At the after bulkhead are three levers coming up from below, which bear inspection and can be better seen from below. Descending the ladder to the engine-room floor, we find the most curious feature of the whole ship. Here is a flywheel, about 10 feet in diameter, on the main shaft just forward of after engine-room bulkhead, used to steady the motion and also to be called in service when the engine stops on a dead center. On the face of the rim of this wheel are cut three sets of ratchet teeth, two in one direction and one in the other. Close above the wheel runs the piston rod from a long-stroke horizontal cylinder, and from this rod may be dropped, by the above-mentioned levers, two pawls, one for engaging either set of ratchet teeth. To get the engine off the center the method is thiswise: If going ahead, the lever controlling the ahead pawl is lowered, the valve on the steam cylinder placed for driving the piston rod to the starboard side, and the steam is turned on; the action of the piston rod will pull the pawl and the wheel over, and thus the crank



VALVE GEAR ON A STEEPLE-COMPOUND ENGINE. THE REVERSING CYLINDER IS SHOWN AT LEFT.

will be brought off center. If stern motion is desired the other pawl is engaged and the steam piston reversed. To get into the shaft alley one climbs down a ladder through the after bulkhead from the upper platform. In place of the usual carefully-designed and more or less complicated thrust bearing, it requires some search to find the thrust block at all on this antiquated type. Close inspection reveals it at the after end of the main journal. It consists of a brass ring with white metal face, pinned to the forward face of crank-shaft coupling, and bearing on the after end of the main journal. The ring is well lubricated. The outside diameter is 20 inches, while the diameter of the shaft is 14 inches. Thus the thrust surface of the engine, which indicates about 1,400 horse power, is but 160 square inches. The engine averages 58 turns. There is no special thrust surface fitted for going astern. The connecting rod has straps at both ends, the lower end being held by two bolts and one key, while in the upper cotter there are two keys. The eccentric rods also have straps at the upper ends.

The air, circulating, bilge, and feed pumps are driven by levers and double links on the crosshead. The other pumps are vertical, with cast-iron standards with flywheels attached.

Passing through from the engine-room bulkhead door one descends several steps to the boiler room, where there are two double-end, return tubular boilers, two furnaces at each end with a common combustion chamber to all four furnaces, fitted with vertical Galloway tubes 14 inches in diameter. The boilers, though built thirty years ago, are in good condition. In 1888 they were fitted with Howden system of forced draft, and now supply steam at 120 pounds pressure.

In view of modern-day practice, it is almost astonishing that such an engine can be run with any profit to the owners, but recently, on 10,000-mile voyages, the coal consumption, for all purposes, has been but 1.8 pounds per I. H. P. The engine runs well, and has required very little repair since the day it was built. One cannot but be struck with the skill and ingenuity of the engineers of the last decade, when he sees such a well-built machine, which has been in constant service for so many years, and when he realizes the disadvantages of tools and material under which the engineers of that time worked. J. W. M.

Novel Launching Ways.

Editor Marine Engineering:

The accompanying photograph may be of interest to your readers as representing an economical and convenient way of launching small craft. The view represents the second of two similar boats built by the Victoria Machinery Depot Company on its own wharf, which has a deep-water frontage and an elevation of 9 feet above normal tide level. Both boats were launched direct from their berths over ways, with the end extension carried over a floating scow 24 by 85 by 5 feet, which was made to serve both boats by simply shifting sideways and lining up with upper end of ways for second boat.

In arranging for the launches the scow, which has two solid longitudinal keelsons, was given initial displacement by partial flooding with water, and trimmed to suit with cast-iron ballast at outer end. To allow for the 4-inch calculated additional submersion due to the launching weight of 30 tons represented by boats, the fixed ways on wharf, which were of 10 by 10-inch lumber, were carried 10 feet over scow beyond the face of the wharf, and were securely dogged to the sills, and at launching the tide was allowed to rise about 2 inches over the level required to bring ways on scow in alignment with upper portion, the inclination in this position being 7-8 of an inch to 1 foot.

This gave such good results in case of the first boat and showed so little disturbance of grade that with the second boat, owing to the tide being late, the boat was launched when the scow was very little more than up to required level. The spring of the 10-foot projection, combined with the speed of boat, gave all the necessary elasticity for passing smoothly over the joint.

LAUNCHING A BOAT ACROSS A BARGE.

Apart from above, the boats themselves have a certain interest as being the first contracts of the kind let by the British government to a local firm, and are also the first steel boats laid down and built in this province. The boats are specially intended for laying submarine mines and are of the standard type used by the Imperial War Office for that purpose. The following are some of the particulars: Length between perpendiculars, 50 feet; breadth, molded, 93 feet; depth, molded, 5 feet; displacement, working condition, 45 long tons; shell plating, outer, 5-16 of an inch; inner, 1-4 of an inch. The fore part, including fore foot, is sheathed on outside with 1 1-2-inch teak. Internally hull is divided by 3 water-tight bulkheads of 3-16-inch plate, and on deck forward are fitted a power-operated crane and other special appliances for handling mines and cables. The machinery consists of a single-furnace, Scotch marine boiler, 6 feet 3 inches diameter by 6 feet 9 inches, to

work at 120 pounds pressure, with a twin set of fore-and-aft compound engines, 6 and 12 inches diameter by 8 inches stroke, arranged to run at 260 revolutions and develop 90 indicated horse power. In addition there are one independent condenser and set of pumps. All piping is of copper, and work in this and deck department is all finished in regular naval style.

G. H. Hardie.

QUERIES AND ANSWERS.

Q. 158.—Will you please inform me whether the crank pin stops at any point of its revolution?

A.—The only time that the crank pin would stop would be when the engine comes to rest. The angular velocity is supposed to be the same throughout the revolution, but, as a matter of fact, there is slight difference in the speed in one revolution; that is, angular velocity. Possibly you have this confused with the crosshead pin, which comes to rest at the end of each stroke or on dead center.

Q. 160.—Will you please tell me in your paper in what respect does the license of an engineer in a gasoline boat for 15 tons differ from that of a steamboat? C. E. P.

A.—By applying to your local U. S. Steamboat Inspector you will doubtless find that the qualifications for obtaining a license for a gasoline boat above 15 tons depend altogether on your experience and ability. There is no set length of previous experience required, as in obtaining a steam license.

Q. 161.—Will you please answer the following in your Queries and Answers column:

Given a vertical compound marine engine to design, 500 indicated horse power, 100 revolutions per minute, 150 pounds boiler steam pressure:

(*a*) Please show method and reasons of obtaining diameters of cylinders and stroke.

(*b*) Also give sizes of cylinders and stroke if the above were a 3-cylinder triple.

A.—In proceeding with a design along these lines it is first necessary to decide on the number of expansions for the steam. For a compound marine engine with steam pressure as stated, from 6 to 8 expansions are usually provided for. Let us take 7 in the present case. Then the mean effective pressure which may be expected, reduced to the l. p. piston, will be given by the usual expansion formula:

$$p_m = f\left[p\left(\frac{1 + hyp.\ log\ r}{r}\right) - p_b\right]$$

From a handbook we find the value of hyp. log 7 to be 1.946. We then find for the value of the parenthesis .421. Then remembering that p is the absolute pressure = boiler pressure plus atmospheric = 150 + 15, or 165, and taking for the back pressure in the condenser, p_b, a value of 3 pounds, we find for the expression in the square brackets:

$$165 \times .421 - 3 = 66.5.$$

This would be the reduced mean effective pressure if there were no losses due to wire-drawing, etc., as shown by the rounding off the corners of the cards. To provide for this the factor f is introduced. Its value with compound engines is usually between .70 and .80. In the present case we may assume a value of .75, which would give for the probable reduced mean effective $.75 \times 66.5 = 50$ pounds.

We then turn to the usual horse-power formula:

$$H = \frac{2\,pLAN}{33{,}000}$$

from which we find:

$$A = \frac{33{,}000\,H}{2\,pLN}$$

In the present case we have $H = 500$, $N = 100$, $p = 50$, while L = length of stroke and A = area l. p. cylinder are unknown. We must, however, make an assumption in order to make progress, and we will therefore take $L = 30$ inches, or 2.5 feet. Then, substituting, we have:

$$A = \frac{33{,}000 \times 500}{2 \times 50 \times 2.5 \times 100} = 660$$

whence diameter = 29 inches. This result shows that the value of the stroke was taken too large. As a second trial we may take 24 inches, or 2 feet. Solving similarly we shall find $A = 825$ and diameter = 32.5. This will presumably do very well for the l. p. cylinder, and we must next determine a suitable size for the h. p. To this end we first note that a cut-off at about .60 will give, taking the clearance into account, an expansion of not much over 1.5 in the h. p. alone. Now altogether we must get an expansion of 7. One step or ratio of 1.5 we obtain in the h. p.; the remainder, or $7 \div 1.5 = 4.66$, we must obtain between the h. p. and l. p. Hence the area of the h. p. will be found by dividing that of the l. p. by 4.66. This gives for the h. p. an area of 177 and a diameter of 15. Hence, as thus determined, the engine would be 15 and 32.5 by 24, with revolutions of 100 per minute. This would give a well-proportioned engine, and, under the conditions assumed, would undoubtedly develop the power desired. If a higher grade of expansion were desired the dimensions would correspondingly vary. Without giving details it may be of interest to note that with a total expansion ratio of 9 the engine would be about 14.5 and 35.5, with revolutions and stroke the same as before.

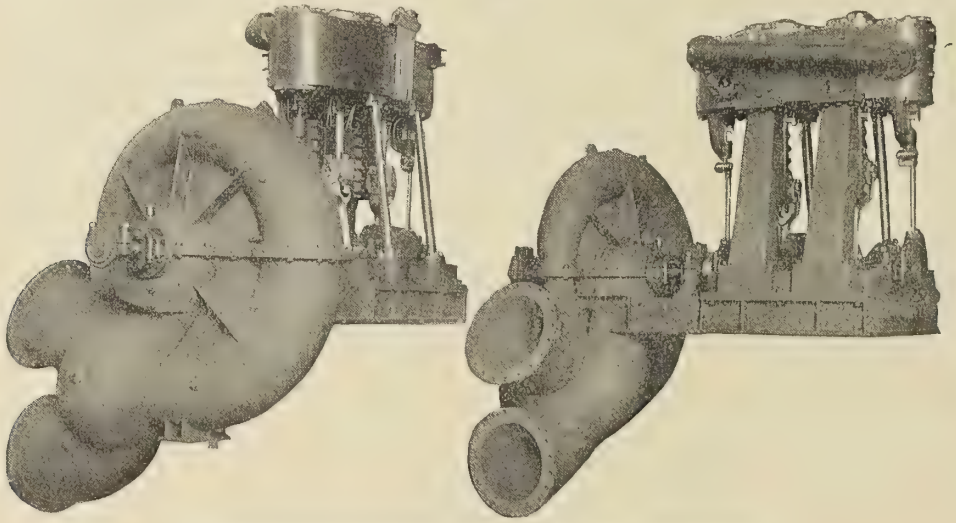
With a triple-expansion engine the general mode of procedure is the same. A suitable total expansion ratio would be 10 or 11, a suitable value of f from .60 to .70, the resulting value of the reduced mean effective about 33, and with a stroke of 27 inches the diameter of l. p. would result 37.5. To find the h. p. we proceed as before. Take the total expansion at 10.5 and divide by 1.5, the probable expansion in the h. p. This gives 7 for the ratio between l. p. and h. p., or for the h. p. area $1104 \div 7 = 158$. This gives 14.2 for the h. p. diameter. Then for the intermediate diameter we may take the square root of the product of the other two, or $\sqrt{14.2 \times 37.5} = 23$. Hence, as determined, the engine would be, say, 14.25 by 23 by 37.5 by 27 stroke and 100 revolutions.

Official Numbers for United States Vessels.—A new system of official numbers for American vessels went into effect on July 1 when the Bureau of Navigation joined the Department of Commerce and Labor. The new series of numbers begins at 200,000, and hereafter new vessels will be numbered seriatim in the order of application for official number, regardless of the initial letter of the vessel's name and of rig or motive power. Thus the official number will indicate approximately the date of build of each new vessel hereafter, being permanently marked on its main beam.

ENGINEERING SPECIALTIES.

Large Compound-Driven Circulating Pumps.

On each of the two Great Northern steamships building at New London, Conn., there will be installed two large condenser circulating pumps built by the Morris Machine Works, of Baldwinsville, N. Y. Each pump has a suction and discharge opening 20 inches in diameter. The pumps are of the double-suction type; that is, the inlet water is divided so as to enter equally on each side, thus the runner is perfectly balanced and there is no end thrust. The runner itself is of the enclosed type and is made of brass, which is the metal used for the casing also. The pump shaft is of manganese bronze and is carried on two bearings entirely outside of the pump, which is somewhat of a new departure with circulating pumps in this country.



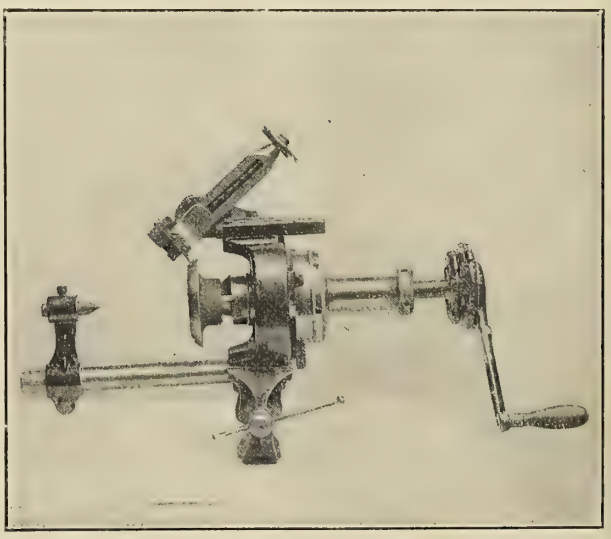
TWO COMPOUND-ENGINE-DRIVEN CENTRIFUGAL CIRCULATING PUMPS.

For ordinary service each pump is to deliver 8,000 gallons of water per minute, to do which the speed of the shaft will be about 200 revolutions per minute. However, the pumps are capable of considerable increase in this delivery by speeding up the engines, and as the engines themselves are built for 250 pounds steam pressure, and with very large wearing surfaces throughout, they are capable of being crowded to a great extent.

A cross-compound engine is directly connected to the pump shaft, the cylinders being 10 and 20 inches in diameter by 10 inches stroke. Both high- and low-pressure cylinders are fitted with piston valves, pistons being of cast steel. The crosshead pins are 3 inches in diameter by 4 inches long; crank pins 4 1-2 inches in diameter by 6 1-2 inches long; crank shaft 4 1-2 inches in diameter. As shown in the illustration, the pump and engine are mounted on a sub-base.

Patent Adjustable Disk-Cutting Device.

The accompanying illustration shows a device used to recut a valve disk with the Smith patent disk cutter. The ring supporting the cutter is held in a vise by a lug, the machine being attached to the ring by the chuck jaws. The valve disk to be recut is securely fastened to the small check or machine spindle and is given a rotary motion by turning a crank at the right. The pointed tool is at the same time fed slowly over the valve disk. With this machine all flat, oval, and taper valve disks, also check-valve disks up to 12 inches inclusive, can be recut. In the illustration the valve cut is oval shape. It will be seen that the top of pointed tool rests against the curved space of block, and that by feeding by means of the handle and screw the tool will travel in an arc, for there is a strong spring holding the tool against the shoulder. The block has two curves for cutting a valve with greater or less curvature; for cutting a disk at 45 degrees the block with the curve is replaced by one with straight edge, and then when the tool is fed it will travel in the path 45 degrees to the center line of valve. A flat disk may also be cut by turning the head around so that it will stand square to the center line of valve. These handy little tools are made by The Leavitt Machine Company, Orange, Mass.



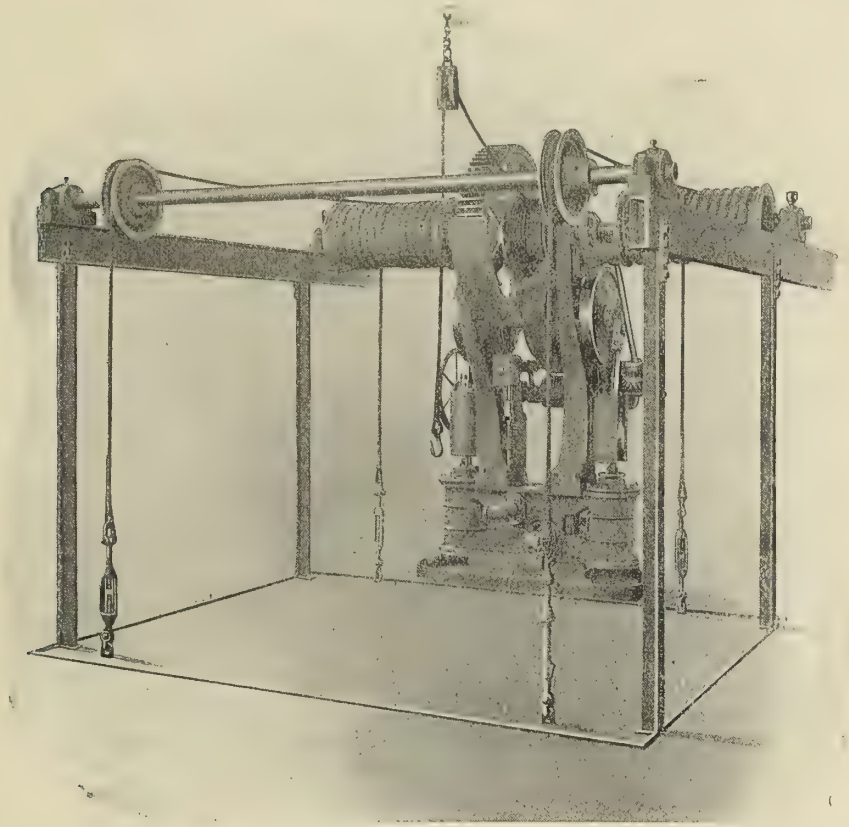
ADJUSTABLE VALVE DISK-CUTTING DEVICE.

Elevators for Use on Board Ship.

Four elevators or hoists, such as shown in the illustration, have been installed on the steamship *Monroe*, recently built at the Newport News shipyard for the Old Dominion Steamship Company. These elevators are steam driven, each having a capacity of 4,000 pounds net load at a speed of 100 feet per minute. The size of the platform is 7 by 10 feet. The engine is fitted with an automatic device whereby at the beginning of a loading operation the platform is automatically brought to a stop when it reaches the lower deck, therefore not requiring an attendant, as is usually the case with all kinds of elevators.

It is intended that when the lower deck is completely loaded this device is to be readjusted, so as to stop the platform automatically when it reaches the next deck, and so on. When all the decks are completely loaded the platform is then lowered to the lowest deck and disconnected. The main winding drums are then thrown out of gear and the whip hoist, which can be seen in the illustration, becomes operative. The hatchway may then be filled with cargo by means of this auxiliary whip hoist. In unloading these operations are of course reversed.

These elevators are compact, simple, and strong in construction, and extremely economical in operation. Full particulars may be had by writing the Otis Elevator Company, 71 Broadway, New York, N. Y.



STEAM-DRIVEN ELEVATOR FITTED ON BOARD SHIP.

Take-up Device.

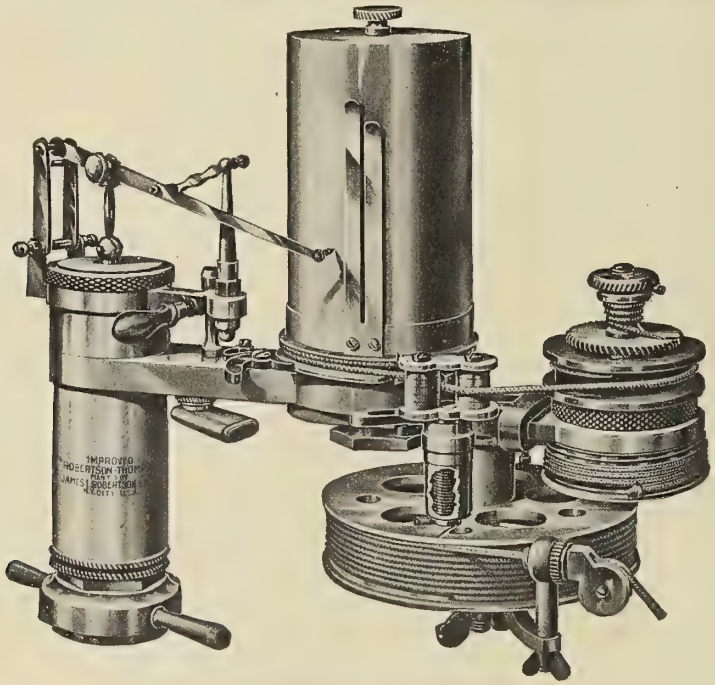
The great trouble experienced when using the detent on the steam-engine indicator is that caused by the slack of the cord between the paper drum and reducing bushing on the wheel. This slack, if not properly guided when throwing on detent, is liable to get foul, thereby in many instances wrecking the instrument, or at least breaking the cord and causing delay and inconvenience to the operator.

The take-up device is designed to do away with this annoyance. It is simple in construction and can be applied to any standard indicator. It consists of a short horizontal arm with a vertical bearing at one end containing a steel pillar, on the upper end of which there is a frame holding a double set of loose steel rollers. Between these the cord from paper drum passes. On the lower end of the vertical pillar there is a light spiral spring enclosed. This spring causes the upper frame to revolve when the cord becomes slack, and is so arranged that the cord winds on frame, to be given up again when tension is applied.

The object of the device is to permit the operator to take as many cards as desired without unhooking from the crosshead or stopping the engine, no matter what speed. This of course pertains to indicators that are fitted with a detent and using a direct-connected reducing motion. Where an indicator is used in connection with other forms of reducing motions not so

much trouble arises, and generally a rubber band is employed to take care of slack cord, which works fairly well. For this case the take-up device is made in the shape of a regular guide pulley to connect to indicator.

It may also be used with satisfaction as a guide pulley alone. Immediately the detent is engaged, it picks up instantly whatever slack cord there is. The tension of the spring in this device being so much weaker than the drum spring, as soon as the detent is disengaged the cord is instantly released and drawn out taut and assumes its regular position. The device is strong, well made, compact, and makes a very attractive attachment. It is good for any number of revolutions and is designed to fit all standard indicators and reducing wheels, or it can be made as a special fixture. Further information may be obtained from the manufacturers, James L. Robertson and Sons, Fulton street, New York, N. Y.



A TAKE-UP DEVICE FOR INDICATOR CORDS.

The Greenaway Separators.

The use of separators is daily becoming more general in all steam engineering. Therefore, the advantages of the Greenaway separators, made by the Nash Regulating Company, Detroit, Mich., will be appreciated. These separators, for both the vertical and horizontal types, are made very strong to withstand a working pressure of 200 pounds per square inch. Much trouble has been experienced in obtaining a good vertical separator. The one illustrated, a 2 1-2-inch, type A, rated at 20 horse power, has been subjected to severe tests at the University of Michigan. When passing 698.7 pounds of steam at 79.3 pounds pressure, the quality of the steam discharged through the separator was 99.5, while the amount of water in the entering steam was 13.69 pounds, or 1.95 per cent. of the total weight. When discharging at excessive overload, the quality was but slightly reduced, thus showing a high efficiency for all conditions.

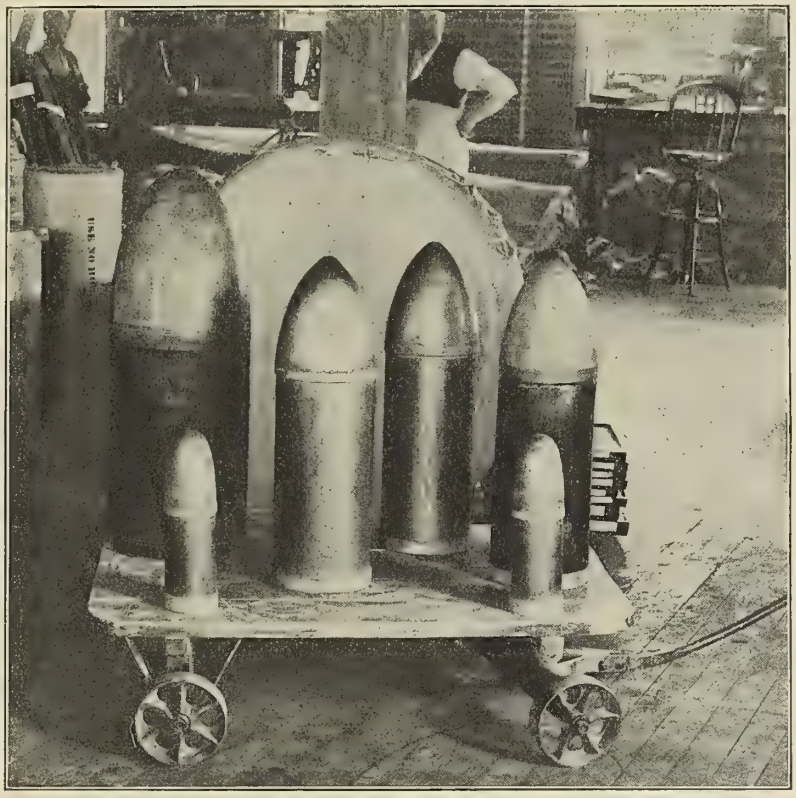
In tests of the horizontal type 869 pounds of steam were passed through the separator at a pressure of 99 pounds. The steam contained 17.39 pounds of moisture, or 2 per cent., while the discharge from the separator contained but .4 per cent. of water, *i.e.*, the quality of the discharged steam was 99.6 per cent.

The construction of each of these types is very simple. The deflecting plates are fitted as shown in the engraving. The efficiency is attributed to the following cause: that steam enters, strikes the deflecting plate, and, owing to the greater specific gravity of the entering water, the water continues on a straight line with the diagonal plate, while the steam, being lighter, flows through the opening and into the discharge pipe.

GREENAWAY HORIZONTAL SEPARATOR.

Rubber Shells.

An interesting illustration of one of the many uses to which rubber is adapted was recently given in Brooklyn at a public exhibition in the armory of the Thirteenth Regiment. The occasion was the review of the regiment by William Cary Sanger, Assistant Secretary of War.



RUBBER SHELLS USED FOR INDOOR TARGET PRACTICE.

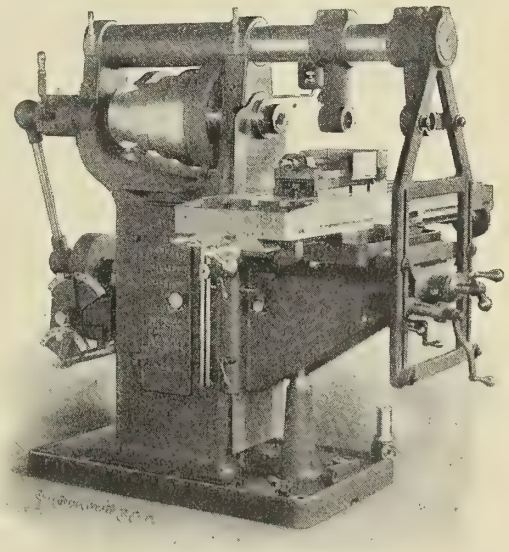
A novel portion of the evening's exercises consisted of artillery practice with 4-inch and 8-inch rubber shells. The squad in charge of the 4-inch gun succeeded in hitting the target almost every shot. The best shot of the performance, however—and indeed the best shot ever made in this kind of practice—was made by the squad in charge of the 8-inch gun, who hit a target consisting of a cartridge placed upright on the floor.

The difficult part of the construction of shells for this work was to get an article which would take the rifling of the gun without being soon cut up and destroyed, or fit so tightly as to destroy the progress of the shot on account of the friction. A number of experimental shells had been made previously, but they all failed in this point, being wabbly and so uncertain that one shot following another would hardly ever strike in the same spot. The present shells, however, are so successful that when a rifle is once aimed the shots will continue hitting the target one after the other, thus making practice work of real practical value.

The rubber shells, of which a photograph is here given, were made by the Voorhees Rubber Manufacturing Company, of Jersey City, N. J., which has made a reputation as a manufacturer of difficult specialties.

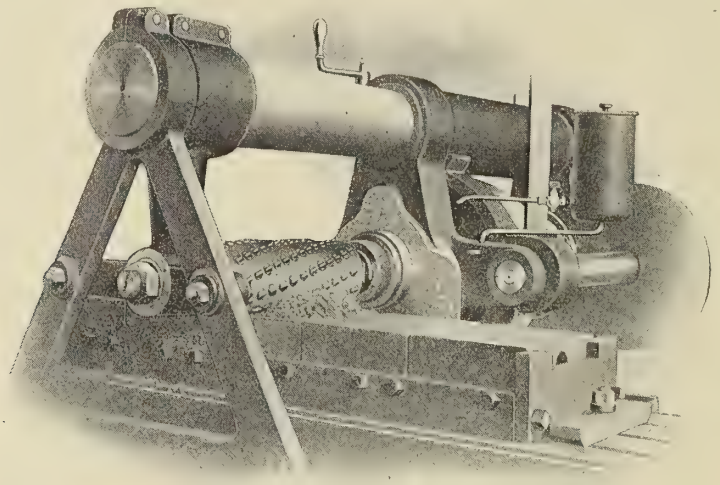
Fast Milling.

The milling machine is daily assuming a more important place in machine shops because of its large output. An interesting example of the speed with which the machines of the Cincinnati Milling Machine Company, Cincinnati, O., turn out work is illustrated in the accompanying engraving. The Cincinnati machine may



CINCINNATI MILLING MACHINE.

be used for all classes of work, such as milling irregular surfaces, engine frames, facing bosses, milling slots, or heavy spiral gearing, spindle shafting, etc., and all classes of vertical milling. The view shows one of these machines working a 4 1-2-inch diameter mill at a cutting speed of 40 feet per minute with a cast-iron surface 8 1-4 inches wide. The cut is 3-32 inch to an eighth of an inch deep, for the purpose of removing scale, and the feed is .252 inch per turn of cutter, which is equivalent to a table travel of 8 1-2 inches per minute. Or, in other words, cast-iron pieces 8 1-4 by 8 1-2 inches are surfaced in one minute, which it will be admitted is a high speed. In finishing work to close limits the proper rate of feed is determined by the foreman; but when a roughing cut is taken simply to clear off scale or excess of stock, or when a flat but not necessarily smooth surface is required, this machine may be driven at a speed as fast as the belts will stand. Thus by increasing the output of the machine the cost of the work is cut down, which in many cases is claimed by this company to be cut down to one-half.



FAST MILLING OF CAST-IRON SLABS.

A Remarkable Light-Weight Boiler.

The latest type of French destroyers, although of increased power and speed, carry, as most of the former boats, only two single-end water-tube boilers. In the *Arquebuse,* which has just been delivered at Cherbourg by Augustin Normand and Company, and in a number of similar destroyers, the two boilers are of the Normand type.

The speed trials, which took place after the ordinary eight-hour consumption trials and the preliminary runs on the measured mile, were of six hours' duration, one hour of which was at or above 24 knots, one hour at full speed, and the remaining four hours at or above 24 knots. In the one hour at full speed, 30.75 knots were attained with 320.38 revolutions per minute and 7,100 English I. H. P., so that each boiler furnished the steam necessary for 3,550 I. H. P. This is probably the record of power for one single-end boiler. No difficulty was experienced in keeping up the pressure.

The weight of each boiler complete, with fittings, stack, ash pit, fire bars, insulating covering, amounts to 19.2 tons without water, and 22.7 tons with water. The total displacement on trial was 299 English tons, including a dead weight of 68 tons, comprising only torpedoes and torpedo tubes, compressing pump, artillery and ammunition, provisions, water for boilers and crew, coal necessary for steaming 1,170 nautical miles at 14 knots (25.02 tons, as determined by the eight-hour preliminary trial), and 9 tons for sundries.

PERSONALS.

Stephen W. Baldwin will retire from the management of the New York office of the Pennsylvania Steel Company, Philadelphia, Pa. He will, however, retain his connection with this company in an advisory capacity of consulting engineer, with headquarters at 71 Broadway, the same as heretofore. Mr. A. E. Aedy, his first assistant for the last fourteen years, has been appointed to take charge of the New York office in the capacity heretofore filled by Mr. Baldwin.

George H. Gibson has resigned as manager of the advertising and publication department of the B. F. Sturtevant Company, Boston, Mass., to accept an appointment with the International Steam Pump Company, New York, N. Y. Mr. Gibson was formerly connected with the Westinghouse Company's publishing department, of Pittsburg, Pa., and was for two years a member of the editorial staff of the *Engineering News* of New York, N. Y.

Charles N. Crowell, who was formerly hull draftsman with the Townsend-Downey Shipbuilding Company, has accepted a position with the Snare and Triest Construction Company, New York, N. Y., and is at the League

Island Navy Yard, where the company is constructing a plant for the government.

Clifton Lee, Jr., formerly with the Crescent Shipyard Company, has accepted an appointment as marine engine and boiler draftsman in the office of Inspector of Machinery, U. S. N., Bath Iron Works.

George Mattsson has left the Detroit Shipbuilding Company to take a position as chief engineer with the Canadian Shipbuilding Company, Toronto, Canada.

LAUNCHES.

Steamer Garden City.—The stern-wheel passenger steamer *Garden City* was launched at Snohomish, Wash., on June 9. The *Garden City* is the first steamer built in Snohomish, and is to ply between that city and Everett on the Snohomish river. She will be the type used in the Puget sound region. The principal dimensions of the *Garden City* are: length over all, 119 feet; beam, 20 feet; depth, 5 feet; with a speed of about 13 miles an hour. The *Garden City* was designed by Allen and Ballord, naval architects and consulting engineers, Seattle, Wash.

Steamer John O. Howard.—On June 21 the steamer *John O. Howard* was successfully launched from the yard of the Columbia Iron Works, St. Clair, Mich. This vessel is the third to be built at this yard. Her principal dimensions are: length over all, 241 feet; over keel, 224 feet; beam, 39 feet; depth, molded, 16 feet. She will be propelled by a triple-expansion engine, 16 by 26 by 44 inches with 36-inch stroke. Steam will be furnished by two Scotch boilers, 10 1-2 by 12 feet, at a pressure of 175 pounds. She will ply between Ogdensburg and Charlotte, on Lake Ontario, and will be equipped with special machinery capable of unloading her cargo within twelve hours. Her designed speed when laden will be 11 1-2 miles.

The Engineers' Strike.

The findings and award of the board of arbitration appointed to investigate and report on the case of marine engineers employed in tug and lighter service of the railways and terminals in the port of New York have been submitted. The arbitrators were W. I. Babcock and Thomas C. O'Sullivan and the umpire Andrew Fletcher, Jr. The settlement of the question of wages follows:

1. Engineers of boats having compound or multiple-expansion engines with low-pressure cylinder 36 inches or over in diameter, wages each, day $120 per month, night $115.

2. Compound or multiple-expansion engines with low-pressure cylinder under 36 inches in diameter, wages each, day $115 per month, night $110.

3. Single-cylinder engines, wages each, day $110, night $105. These rates to be flat.

The question of meals and payments for same was mutually agreed upon between each company and its own men; no reduction to be made in these rates when a boat is laid up for repairs or otherwise, if the engineer is retained on board. The owners are to allow cost of transportation to and from the regular reporting port of the boat. Two days off each month and one week's vacation each year shall be allowed each man without reduction of pay.

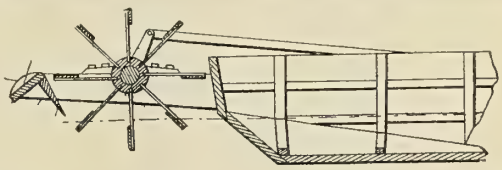
TECHNICAL PUBLICATIONS.

The Alternating-Current Transformer. By F. G. Baum, Stanford University. Size 8 inches by 6 inches. Pp. 195, with 122 diagrams and figures in the text. McGraw Publishing Company, New York, N. Y. Price $1.50.

This book is the development of a series of lectures given to university students, and is intended to present the main points of both theory and practice, especially as related to modern design. Some general acquaintance with alternating currents is assumed, but in general the treatment is such that the book should be read without difficulty by those for whom it was intended. There is a growing feeling among teachers of electrical science that the alternating current, as presenting the most generalized form of the problem, should be first studied, and that a thorough understanding of the phenomena of such currents will leave but little remaining with reference to the more special problem of direct currents. This book is written apparently in sympathy with this view, and gives in a clear and concise form the leading facts of theory and practice which relate to the particular field under consideration. For those familiar with the usual college mathematics the book should prove an interesting and valuable contribution to this field of engineering science.

SELECTED MARINE PATENTS.

730,889. BOAT. STEPHEN A. DUVALL, PENRITH, W. VA.



Claim.—The combination with a boat provided with paddle wheels, of a scraper secured to the rear of the paddle wheels and provided with a forwardly-inclined scraper adapted to have its lowest edge in close proximity to the blades of the wheel and slightly above the level of the water so as to cut off the water raised by said wheel, and a downwardly-inclined apron or top to cause the water scraped from the wheel to be converted downwardly. One claim.

731,020. PROPELLER FOR VESSELS. BERNT CHARLES, NEWARK, N. J. Four claims.

731,029. METHOD OF UTILIZING THE ENERGY OF WAVES. REGINALD A. FESSENDEN, PITTSBURG, PA. Seventeen claims.

731,110. BARGE-STEERING AND RETARDING MECHANISM. IRA H. LARR, SULLIVAN, IND.

Claim.—1. A fleet of vessels comprising a towing vessel and a line of following barges, steering and speed-retarding devices carried by each barge, and means for connecting such devices to the towing vessel.

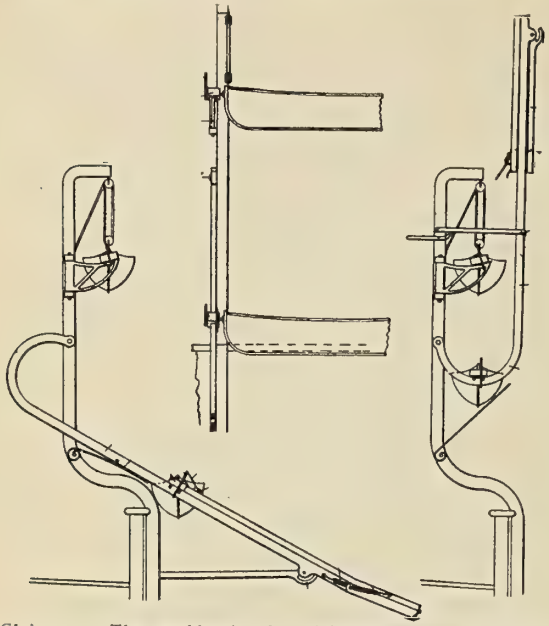
2. A fleet of vessels comprising a towing vessel and a line of following barges, a steering device arranged at each side of each barge, and means for connecting all of the steering devices on the port side for simultaneous operation, and for connecting all of the steering devices on the starboard side for simultaneous operation. Five claims.

731,138. SKYLIGHT FOR VESSELS. WILLIAM B. STEARNS, MARBLEHEAD, MASS.

Claim.—1. In a skylight, the combination of a ridge having a gutter, a skylight hinged to the outer edge of said gutter having means for substantially closing the entrance to said gutter.

2. In a skylight, the combination of a ridge having a gutter provided with a pivot on which the skylight works, and a skylight having a hinged member which interiorly engages said pivot, and means connected with said hinged member which projects into and substantially closes the entrance to said gutter and works in said entrance as the skylight is operated. Six claims.

731,143. LIFEBOAT-LAUNCHING APPARATUS. SOLOMON H. URY, SAN LEANDRO, CAL.



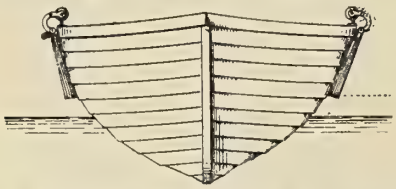
Claim.—1. The combination in a lifeboat-launching apparatus, of supporting and launching means, ways pivoted to said supporting means, bars hinged to the outer ends of said ways, spring connections between said ways and their respective bars by which the latter are normally folded over upon the ways, and shoes at the ends of the boat and engaging said ways, substantially as described, slidable upon the ways. Four claims.

731,491. TIDAL ELEVATOR. CLEMENT D. O'LEARY, PROVIDENCE, R. I. Four claims.

731,500. SUBMARINE-BOAT STRUCTURE. HERBERT N. RIDGWAY, WINTHROP, MASS., ASSIGNOR TO AUTOMOTUS BOAT COMPANY, BOSTON, MASS., A CORPORATION OF MASSACHUSETTS. Six claims.

731,514. PROPELLING MECHANISM FOR BOATS. MORRIS N. SHEEN AND DANIEL R. SHEEN, PEORIA, ILL. Seven claims.

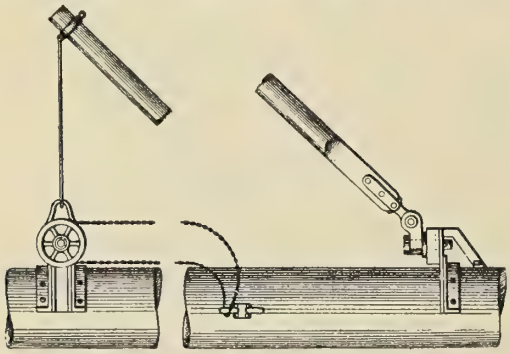
731,515. OUTRIGGER FOR BOATS. DANIEL R. SHEEN AND MORRIS N. SHEEN, PEORIA, ILL.



Claim.—1. In a device for preventing the tipping of boats, the combination of the boat, a collapsible air receiver secured to each side thereof and means for automatically opening and closing said receiver.

2. In a device for preventing the tipping of boats, the combination of the boat, a collapsible air receiver secured thereto, and means for automatically keeping the same close to the side of the boat when not in use, such means also adapted for opening the same when the boat is tipped. Five claims.

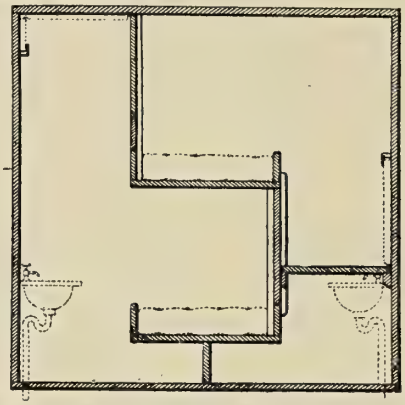
731,584. DERRICK FOR SHIPS. DUNCAN F. MACDONALD, GLASGOW, SCOTLAND.



Claim.—1. In a derrick or crane, the combination with the standard, of guides attached to the standard, a block arranged to slide between said guides, a jib having a head connected by a tie to said block, and means for moving said block laterally upon the guides. Four claims.

731,751. ALIDADE OR INDICATOR FOR SHIPS' COMPASSES. WILLIAM S. BURGESS, BOSTON, MASS. Three claims.

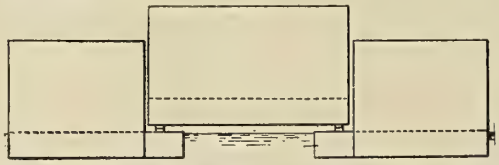
731,848. STATE ROOM FOR SHIPS. JOHN W. BOUGHTON, PHILADELPHIA, PA.



Claim.—1. A plurality of state rooms that adjoin, each having a berth therein, the berths being separated from each other, and means whereby the rooms may be placed in communication and the berths made common to both rooms.

4. In a plurality of state rooms that adjoin, a berth for each room, one berth being above and separate from the other, a movable vertical partition between the upper berth and ceiling, and a movable vertical partition between the two berths. 4 claims.

731,858. FLOATING DOCK. LYONEL E. CLARK, LONDON, ENGLAND.

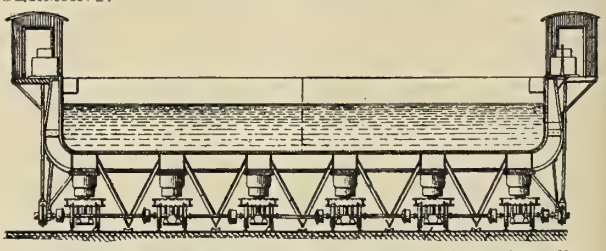


Claim.—1. A floating dock comprising central and terminal sections, each U-shaped in cross section, said terminal sections each having a tongue adapted to extend between the side walls of another section and rest on said section between said walls.

2. A floating dock comprising central and terminal sections, each U-shaped in cross section, and adapted to be securely fastened together to form a rigid structure, each terminal section having a projecting tongue adapted to enter between the side walls of another section, and each section of the dock being constructed with water-tight compartments, and having a lifting power such that any two sections are capable of lifting and supporting any one of the other sections. Two claims.

731,869. APPARATUS FOR REGULATING THE SPEED OF PROPELLER SHAFTS. THOMAS A. DUIFF, ROTTERDAM, NETHERLANDS. Three claims.

731,945. SHIP RAILWAY. OTTO PHILIPP, KÖTHEN, GERMANY.



Claim.—1. In a ship railway, the combination of a tank cradle, a framework for the same, pedestals on said framework, trucks for supporting said cradle, and pneumatic cushioning devices between said pedestals and trucks. Five claims.

The Cramp Loan.—The stockholders of the William Cramp and Sons Ship and Engine Building Company have approved the plan of board of directors to increase the capital stock from $5,000,000 to $6,250,000 and the bonded indebtedness from $1,800,000 to $7,500,000. Drexel and Company, the bankers who have underwritten the loan, will purchase a series of the shipbuilding company's notes to the extent of $5,000,000 with interest at 5 per cent. and maturing in annual instalments during a period of 20 years.